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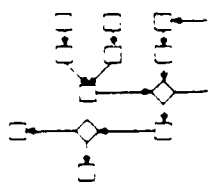
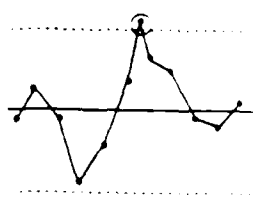
TOTAL QUALITY MANAGEMENT GUIDE

A TWO VOLUME GUIDE FOR DEFENSE ORGANIZATIONS

VOLUME I – KEY FEATURES OF THE DoD IMPLEMENTATION





Department of Defense
Washington, D.C.

FOREWORD

Government and industry have come to understand that previously acceptable quality norms of goods and services are no longer acceptable.

Customer satisfaction, reliability, productivity, costs, and for industry, market share, profitability, and even survival are directly affected by the quality of an organization's products, services, and performance.

Therefore, it becomes essential to develop attitudes and systems—at all levels of an organization—that promote and implement continuous improvement of procedures, processes, products, and services. Those attitudes and systems are the focus of Total Quality Management (TQM).

This guide supports the implementation of DoD Directive 5000.51 on Total Quality Management and is designed to provide a basic understanding of TQM. Executives and managers may find the guide to be particularly useful in this regard. Also, its use is encouraged to support training.

The implementation of TQM in any organization must take into consideration such factors as the organization's unique product or service, culture, customers, level of knowledge, and experience.

This guide, therefore, must be tailored to its specific application. The guide provides one approach, but others are possible. Innovative approaches are encouraged.

This guide is not to be contractually mandated (reference: DoD Directive 5000.43, Acquisition Streamlining).

If you have comments to contribute to the continuous improvement of this document, please forward them to:

Office of the Deputy Assistant Secretary of Defense
for Total Quality Management
OASD(P&L) TQM
Pentagon, Washington D.C. 20301

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INTRODUCTION

While the United States continues the longest peacetime expansion in its history, it is quite evident that we are besieged by serious concerns that threaten our very industrial existence. Coupled with the need to tackle the trade deficit, the overwhelming budget deficit, and rapid loss of standing in economic and technological fields, it is imperative that we change our quality culture. Serious and pernicious short-falls in our quality practices and shortsightedness in limiting our view of quality have been costly in the extreme.

The Evolution of Causes—In the industrial sector, many industrial leaders became preoccupied with short-term profits and corporate mergers. Unfortunately, in doing so they failed to focus on customer satisfaction, which is not achieved by sales gimmicks, but by quality products as the fundamental basis for a successful business. They failed to set in place a long term vision for their companies, and to communicate that vision to the work force. They treated quality as an added burden and an added cost, failing to understand that high quality in every process is the key to profitability and increased market-share. Regrettably, they even lost sight of inherent abilities of their workers to contribute to process improvement. The result has been apathy, loss of self esteem, loss of pride in workmanship, indifference to product quality and absenteeism.

The Need for Cultural Changes—Our present culture is permeated by an atmosphere of distrust. We devise intricate checks and balances to control every action with a bureaucracy that boggles the mind and causes excessive administrative costs. Meanwhile, we fail to train our managers for leadership, pay little attention to the system that allows counterproductive efforts to go unchallenged, do not properly educate, train or motivate our personnel to be effective and productive, nor do we allow them to contribute to the full extent of their abilities. The fact is that our management style focuses on the failures with elaborate procedures that measure failure and prescribe the proper punishment. All this emphasis on detecting failures, almost invites a challenge to try and get away with as much as possible. Rather, we should be putting the desired achievements on the spot light, provide leadership and incentives for success, and measure and reward in accordance with achievements.

The Department of Defense has for many years stressed the application of sound quality practices. However, our quality programs have been attuned to product complexity and inspection, and the results have been far short from the excellence we thought we were demanding. The basic concept was flawed with its concentration on inspection of the product for conformance with emphasis on identifying and managing defects. This limited vision of quality attempts to stop defective products at the plant's door, but leaves behind a trail of inefficiency, cost growth,

waste, repair and rework. It lacked the necessary emphasis on building quality into every process that impacts design, manufacturing and distribution. The implication is that inspection alone at the end of the process is too late, and that conformance to inadequate requirements leads to poor quality We have recognized that a process implies the blending of incoming resources: people, methods, material, equipment and environment. This blending must be so constituted as to add value to the outgoing product or service. This does not mean that we will do away with all government inspectors. Rather, government oversight will change from the large scale product inspection and specifying the "how to " requirements to increased emphasis on monitoring the controls of processes and ensuring achievements of results while limiting specifications to performance requirements.

DoD's Contributions to the New Culture—The DoD Total Quality Management is aimed at transforming how the DoD does business both internally and with its contractors and suppliers. TQM is based on the well articulated concepts pioneered by such visionaries as Deming, Juran, and Fiegenbaum, and employs not only the traditional statistically based problem solving techniques, but the more modern approaches of Ishikawa, Taguchi and others. The operative concept of TQM is "continuous process improvement" involving everyone in the organization, managers and workers alike in a totally integrated effort toward improving performance of every process at every level. This improved performance is directed toward satisfying such cross-functional goals as Quality, Cost, Schedule, Performance, Manpower Development and Product Development. The ultimate focus of every process improvement is increased customer/user satisfaction. Not incidentally, the customer/user's views are actually sought in developing the process improvement methods.

The DoD Total Quality Management Approach—DoD is giving top priority to implementation of a Total Quality Management approach as the vehicle for attaining continuous quality improvement in DoD operations. TQM is directed at tapping the creativity of every manager and worker to continuously upgrade the quality of their functions, so as to better satisfy the ultimate users of DoD weapon systems and equipment. TQM will focus on continuous process improvement of every facet of its work, i.e.: internal operations, weapon system requirements formulation, design, development, production planning, source selection, manufacturing, fielding and support. To accomplish this, we must provide the climate to encourage new ideas, and procedures to better manage development and implementation of changes.

Many American companies have already seen the light and are moving in the TQM direction. They are not doing it for unknown reasons. Most have been bitten by high scrap and rework costs, recalls, customer complaints, and most of all the competition that threatens the vitality of their businesses. They have come to understand that quality, achieved through continuous process improvement, translates into reduced cost, improved product quality and reliability, increased productivity, customer satisfaction and increased profits and market share. The DoD goals are quite similar except that our emphasis is on "the satisfied quality-equipped, quality-supported soldier, sailor, airman and Marine."

The DoD Total Quality Management strategy is structured to change our quality focus; quite literally to change the quality culture of the DoD establishment, its contractors and their principal subcontractors. TQM is not just another program. TQM seeks to raise a collective vision of quality and is premised on "Continuous Quality Improvement," a never ending process. This means focusing on all of the processes that, in their totality, determine the quality of the product: every design process, every development process, every manufacturing process, every quality assurance process and, very importantly, every administrative process. Quite simply, TQM says, "If your quality is not improving, it's deteriorating; there is no *standing still.*"

The Continuous Quality Improvement Concept—The objective of TQM is to broaden the focus of quality to embrace the concept of continuous process improvement. To change the concept of quality from defect correction to defect prevention; from quality "inspected" into the product to quality designed and built into the product; from acceptable levels of defects to continuous process improvement; from approval of waivers to conformance to properly defined requirements; from emphasis on cost and schedule to emphasis on quality, cost, and schedule.

TQM goes far beyond the traditional quality assurance system and product inspection. TQM is process oriented and encompasses the following:

1. The quality of management. Effective leadership, both internally and at DoD contractor and principal subcontractor levels. TQM demands involved, participating and high quality management of all processes that add up to acquisition.

2. The quality of all processes. Every functional element in the DoD and industry must continually search for process shortcomings and devise ways to gradually overcome them through a continuous improvement process.

3. The quality of the integrated hardware/software systems and services provided to our field users. With respect to product quality, TQM expands the definition from the product conformance focus to one which starts with the definition of correct requirements; then with the achievement of conformance to these requirements; not exclusively through inspection, but predominantly through continuous process improvement; and finally, the achievement of total user satisfaction. It should be clear that total conformance to an **incorrect** requirement results in a perfectly **incorrect** product.

Full implementation of TQM will require time, because it involves retraining of the work force and concerted step-by-step improvement actions; but, the benefits to be derived are well worth the effort.

DoD Guide

This guide describes the key features of TQM and provides guidelines for implementing them. The contents of this guide are in accordance with **DoD Directive *5000.51***, *which sets forth the policies and responsibilities for* TQM implementation.

Section 1 **Total Quality Management Strategy**, defines what TQM is and discusses some of the underlying precepts.

Section 2 **Total Quality Management Model**, then presents a step-by-step approach for implementing TQM.

Section 3 **Tools and Techniques of Total Quality Management**, describes some of the tools available to perform the steps of the TQM Model.

Appendix A **TQM Related Initiatives in Systems Acquisitions**, then discusses some of the other DoD initiatives related to TQM.

Appendix B **Appendix**, provides additional references and definitions for the reader who desires more detailed information.

Strategy

TOTAL QUALITY MANAGEMENT STRATEGY

Definition

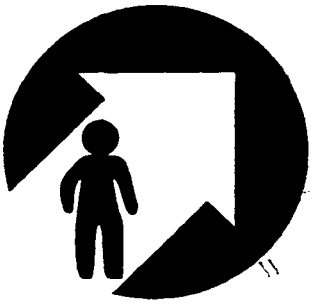
Total Quality Management (TQM) is both a philosophy and a set of guiding principles that represent the foundation of a continuously improving organization. TQM is the application of quantitative methods and human resources to improve the material and services supplied to an organization, all the processes within an organization, and the degree to which the needs of the customer are met, now and in the future. TQM integrates fundamental management techniques, existing improvement efforts, and technical tools under a disciplined approach focused on continuous improvement.

DoD policy and some perspectives on TQM are provided on the following pages.

DoD Policy

- Principles of TQM must involve all DoD personnel, processes, products, and services, including the generation of products in paper and data form.
- Process management, process improvement, and process measurements are fundamental management approaches, which are to be used as appropriate by all DoD managers.
- TQM concepts are to be among the fundamental management tenets of every DoD activity and are to be ingrained throughout DoD with tailored training for each organizational level, starting with top management.
- Managers and personnel at all levels must take responsibility for the quality of their processes and products. Accurate quantitative measures of quality should be established as a basis for informed improvement action.
- Involved, competent, dedicated employees make the greatest contributions to quality and productivity. They must be recognized and rewarded accordingly.
- Acquisition Strategies will address plans to measure and pursue continuous process improvement in order to provide products and services that will provide best value.
- TQM will be a key consideration in source selection.
- Emphasis must change from relying on inspection, to designing and building quality into the processes that affect product quality.
- Technology, being one of our greatest assets, must be used, where appropriate, to continuously improve the quality of defense systems, equipment, and services.
- Continuous process improvement is a key to performance improvement and must be pursued with the necessary resources to achieve the desired cultural change in DoD.

Pursue New Strategic Thinking

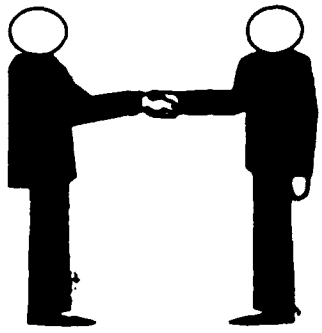


The TQM philosophy provides a comprehensive way to improve quality by examining the way work gets done in a systematic, integrated, consistent, organization-wide perspective.

The focus is to:

- ❑ Institutionalize continuous improvement of processes, not merely compliance with standards
- ❑ Manage to improve processes from within, rather than wait for complaints/ demands from users
- ❑ Involve all functions, not just the quality organization
- ❑ Enable employees to become the driving force for improvements
- ❑ Use guides and target values as goals to improve on
- ❑ Use appropriate process control techniques
- ❑ Understand the effects of variation on processes and their implications for process improvement
- ❑ Design in quality, not inspect out defects
- ❑ Involve suppliers in the improvement process as a responsive partner, not as adversaries
- ❑ Emphasize optimum life cycle cost (best value), not merely lowest initial procurement cost.

Know Your Customers



Providing customers/users with products and services that consistently meet their needs and expectations.

User satisfaction is the ultimate requirement to which everyone must strive whether the user is an **internal** customer or an **external** customer. A "customer" or "user" is a generic term for the recipient or beneficiary of a process's output, i.e., the resulting product or service. Similarly, a "supplier" is anyone who provides input to a process.

The ultimate users are the service personnel in the field. They require products and services that satisfy their expectations for technical performance (including logistic support) and schedule (available when needed). The only way the user can ultimately be satisfied is if the product or service meets the user's need or intended use at a reasonable cost. In the DoD environment, it is critical not only to meet the user's needs, but to anticipate them.

Set True Customer Requirements

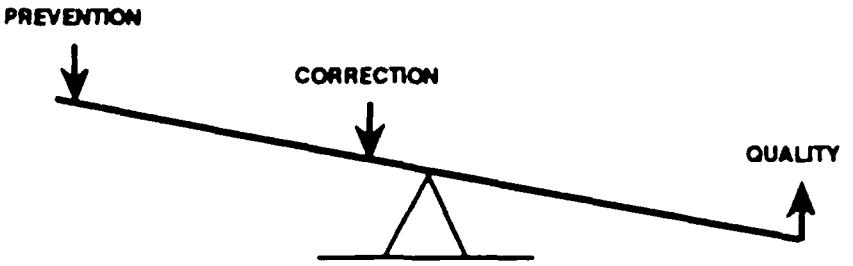
Quality is conformance to a set of customer requirements that, if met, result in a product or service that is fit for its intended use.

Knowledge of the customer's needs and expectations (internal and external) is a prerequisite to satisfying them. It is critical that these requirements be understood and reflected accurately in specifications for products, services, and processes. The manufacturing-oriented definition of quality, "conformance to requirements," only leads to user satisfaction when there is alignment between user expectations and user requirements.

For example, meeting procurement specifications becomes a concern to be pursued only after the user's requirements have been defined. Conformance to Government or industry specifications will result in quality products only when those specifications properly define user requirements. If they do not, blind adherence to specifications can easily become counterproductive.

Responsibility for ensuring that customer requirements are thoroughly understood to effectively assess manufacturability, producibility, and supportability rests with both the customer **and** the supplier. The earlier in the process this is done, the more cost-effective and efficient the upstream operations will be. The suppliers include the prime contractors and sub-contractors.

Concentrate on Prevention, Not Correction

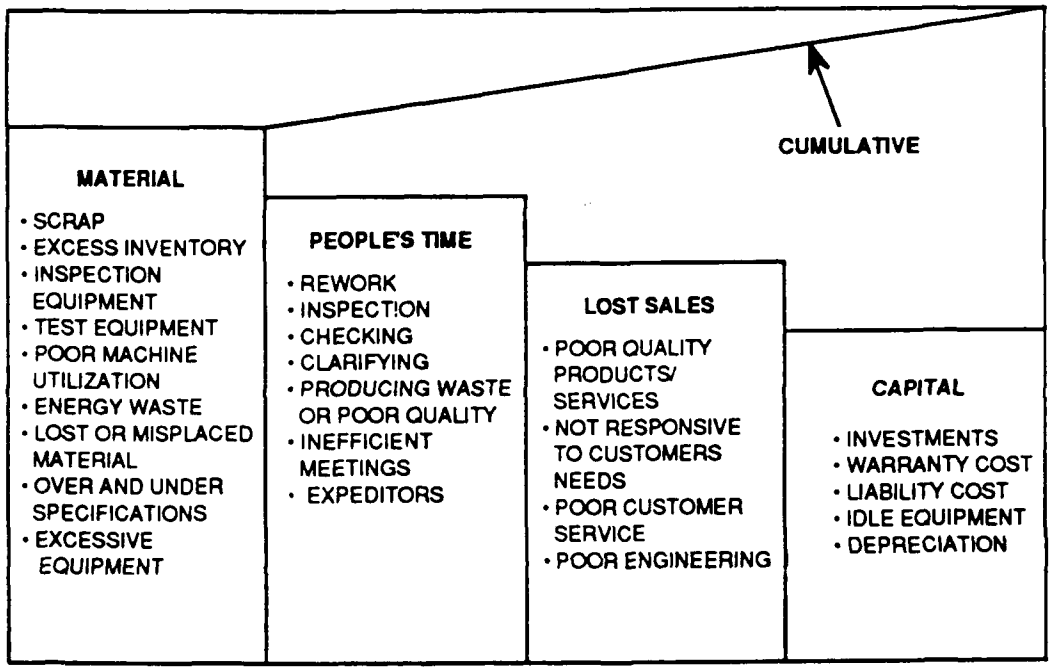


PREVENTION HAS MORE LEVERAGE WHEN IMPROVING QUALITY

A manager who fails to provide resources and time for prevention activities is practicing false economy.

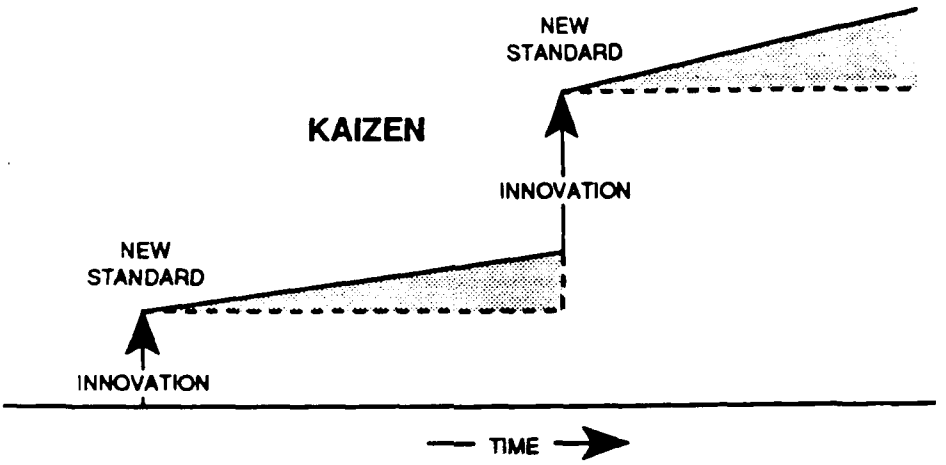
The quality payoff is maximized when considered during early phases of developing a product or service. It is then that many problems can be **prevented**. Thereafter, the leverage of prevention is reduced as **correction of problems**—a more costly procedure—becomes the dominant mode. A key aspect of this concept is designing products and services that can be produced with high-yield within the capability of the manufacturing or service process. Designs that are immune to variability in manufacturing and operational use are said to be **robust**.

Reduce Chronic Waste



Experts estimate that the cost of waste in many large organizations is significant. Whatever the exact numbers are, they illustrate the extraordinary opportunity for reducing costs through improvement of quality. Much of the high cost of poor quality comes from processes that are allowed to be wasteful. Waste is defined as anything that does not add value to the product or service. This waste is often **chronic** and is accepted as the normal cost of doing business. The conventional approach to quality is not to get rid of chronic waste but to prevent things from getting worse by "putting out the fires." Chronic waste of time, material, and other resources can be driven down by implementing continuous process improvement.

Pursue Continuous Improvement Strategy



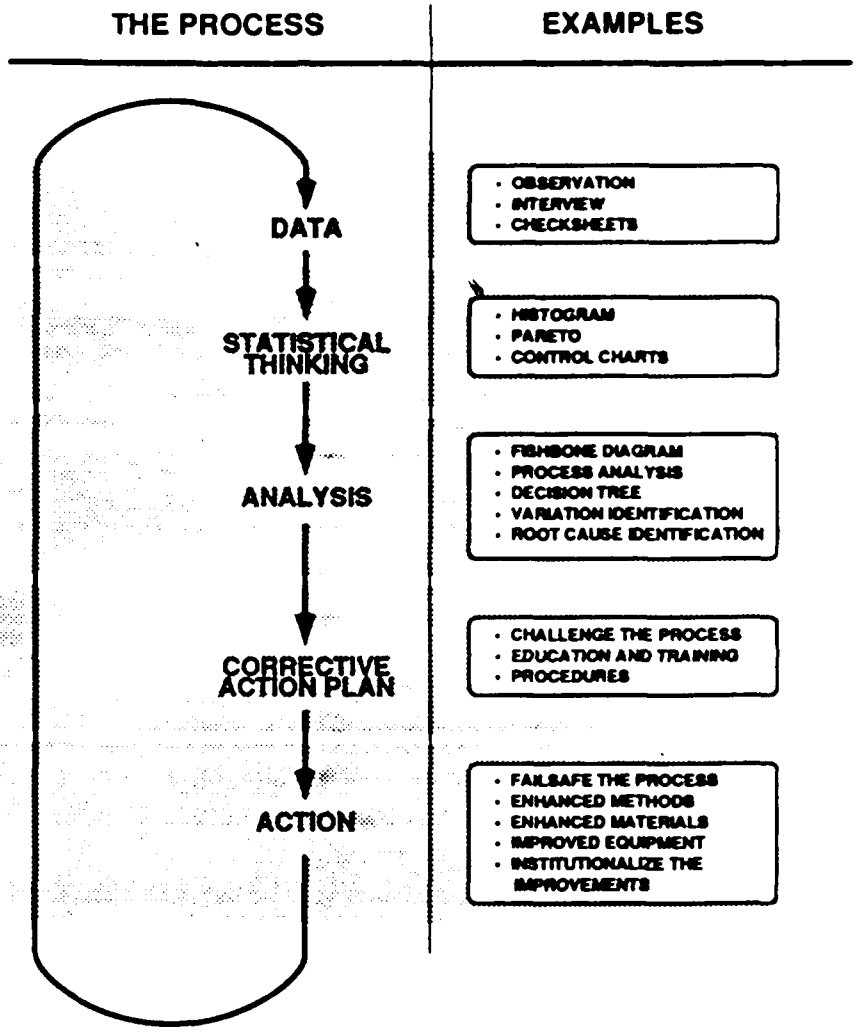
CONTINUOUS INCREMENTAL IMPROVEMENT

While breakthroughs are certainly a key part of the improvement process, continuous "fine tuning" is often overlooked. The timing of true breakthroughs is hard to predict—while waiting for one to arrive, an organization's level of performance often declines because of lack of sustained attention.

The Japanese place a high priority on continuous incremental improvements (called **Kaizen**) that, over time, leapfrog the competitors who depend solely on the "Hail Mary touchdown pass."

By practicing continuous improvements, managers demonstrate leadership and commitment to quality. Additionally, workers, supported by managers, become a major source of improvements.

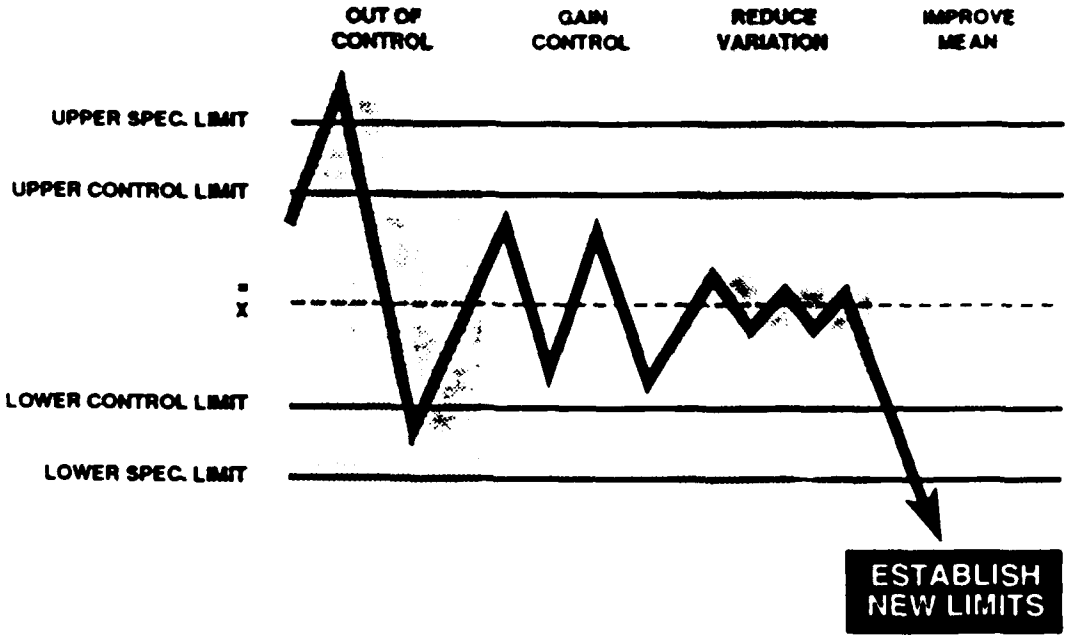
Use Structured Methodology for Process Improvement



Structured problem-solving methodologies can help to identify opportunities for improvement. Every work activity (also called work function or work process) has inputs and outputs. Critical points in the process should be selected, and measurements should be taken at the input, at the output, and within the process.

These measurements will provide the feedback if the continuous improvements are being accomplished, and help identify the most serious problems to be resolved. Tools such as histograms and Pareto diagrams help to determine the most likely cause of the problems leading to waste. Techniques such as brainstorming, experimentation, or cause-and-effect analysis are used to develop alternatives and arrive at solutions. Finally, corrective action is taken to resolve the problems and improve a process. This cycle is repeated indefinitely, resulting in a continuous quality improvement process.

Reduce Variation – an Applied Example of Continuous Improvement



Statistical tools are valuable for applying the continuous improvement philosophy. An example is variability reduction. Ideally, all products should be built to nominal dimensions. Unfortunately, this is not realistic; therefore, tolerances come with each nominal. However, variations in parameters do contribute to higher costs of quality and lower reliability. The latter is often due to the effect of the "stacking of tolerances." While the variation cannot be eliminated, it can be significantly reduced by identifying and removing the causes of variation, whether they come from the design of the project or service or the production process.

The steps to reduce variation include:

1. Bring uncontrollable processes under control.
2. Reduce the variation.
3. Improve the mean.

For example, the effects of manufacturing variability can be minimized by appropriate design choices. Design choices might include characteristics of the manufacturing process, such as type or amount/thickness of material used, speed/feed/feed of cutter, temperature and time of heat treat process, etc. Such a design is said to be a **robust** design because it has been desensitized to manufacturing variation.

(Continued on the next page)

People often think that **99 percent quality** is good enough. However, at this level, there would be **5,000 incorrect surgical operations** per week and **2 short or long landings** at most major airports each day—not an encouraging prospect for anyone who flies or requires surgery.

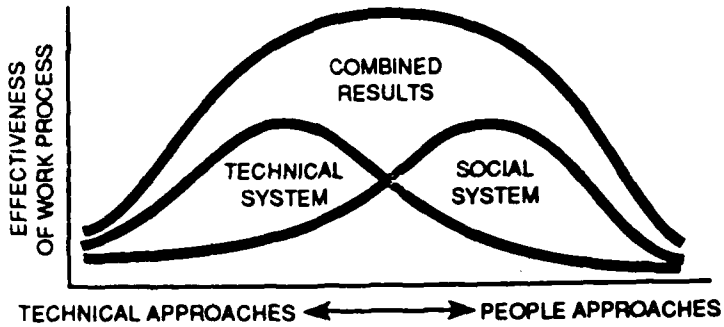
Some think that the often-used criterion of **3 sigma variation** (99.73%) is good enough. Even at this level, **one would only expect 1 good unit out of every 15 units** for a product composed of 1,000 parts.

That is why the traditional use of setting quality levels at the "percent defective" level is now changed to measuring quality as **parts per million**. This is being achieved in progressive companies by:

- ❑ Setting **parts per million tolerances** on all **critical** product and process parameters to improve process capability
- ❑ Using **stable technologies** in new design
- ❑ **Minimizing** the total number of parts in the product and steps in all processes
- ❑ **Standardizing** the parts and processes
- ❑ Using of **experimental design** methods to optimize processes
- ❑ Concurrently designing products and their manufacturing process to **build in "robustness"** (concurrent engineering)
- ❑ **Involving suppliers** in all of the above activities.

Improvement almost always requires reduction of variation, and it may also require movement of the average to a higher or lower level.

Use a Balanced Approach



The TQM philosophy emphasizes the importance of people in the total process. Considerations such as culture, incentives, teamwork, training, and work involvement are typical. The optimum effectiveness of TQM results from an appropriate mix of the social and technical systems. It is common practice to emphasize the technical aspects of improvement—new machine tools, computers—with less emphasis on the people and their role in the process.

Improving quality and productivity to achieve competitiveness re-emphasizes the need for an enterprise to capture the potential inherent in its workforce by enabling each employee to do his or her job right the first time. Management must ensure that employees:

- ❑ Receive proper training
- ❑ Get feedback on their performance
- ❑ Are empowered to make changes necessary to improve the process (with barriers to employee contributions removed).

This also requires that top management demonstrate to all employees that they are personally involved.

Management must provide an environment in which **all** employees will voluntarily cooperate to achieve the organizational objectives. This requires that management accept the idea that employees can and want to contribute and encourage the flow of ideas up. Reducing the hierarchical levels in an organization can facilitate this process.

(Continued on the next page)

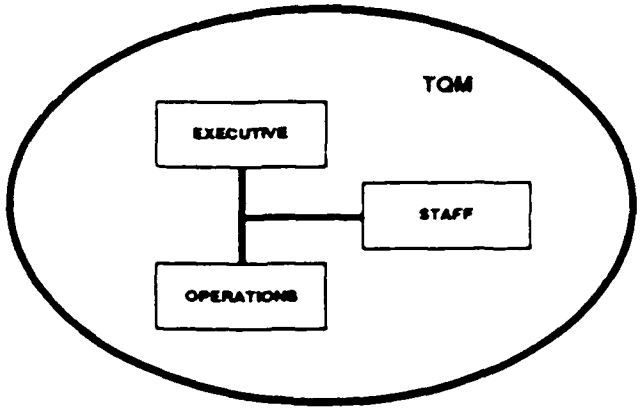
Employees will expend the necessary effort when they perceive that their performance will lead to desired rewards. Rewards are both extrinsic (salary, bonuses, recognition, and work security) and intrinsic (meaningful work, responsibility for outcomes, and feedback on the results of work activities).

Employees model their behavior on how management acts. Management must demonstrate by their actions that quality is extremely important and lead and manage employee involvement in quality improvement efforts.

Group activities are an effective way to tap the human resource to achieve quality improvement. Through teamwork employees gain pride in their work and develop a personal stake in the achievement of excellence in quality and productivity.

Group activities are also an effective way to bridge the interface between functional disciplines. In group activities, the integration of design, quality/reliability, and production is an effective way to achieve the synergy necessary for quality excellence. Various names have been given to the team approach like **simultaneous engineering** and **concurrent design.** These teams can range from 4 members to 10 members and can have representation from any function in the organization. Some organizations are now using teams as the basic building block for organizational structure.

Apply to All Functions



Although TQM is typically discussed with respect to manufacturing activities, it extends beyond the assembly line. As the name implies, TQM strives for **total** optimization of an organization, and should encompass all functions.

Non-manufacturing functions include administrative activities, research, accounting, and human resources activities. These functions all generate products, which means a process exists and can be improved. In fact, such "white collar" areas often represent the greatest opportunity for quality improvement.

As in the case of manufacturing processes, analysis of non-manufacturing processes involves looking at the customer requirements, the actual output, the actions in the process, and the input received from suppliers. The same analysis tools and techniques are used in both cases. Likewise, the emphasis on prevention and understanding customer requirements applies equally to all processes.

Production of a Machine Bolt vs. Accounting Report

	BOLT	REPORT
PROCESS	MACHINING BOLT	PREPARING REPORT
TYPICAL ACTIONS	Set up lathe cut metal	Put report into correct format
INPUT	Metal bar stock	Data
OUTPUT	Bolt	Report
CUSTOMER	End user	Managers
SUPPLIER	Maker of bar stock	Employees providing data

Model

TOTAL QUALITY MANAGEMENT MODEL

A Model for Continuous Improvement

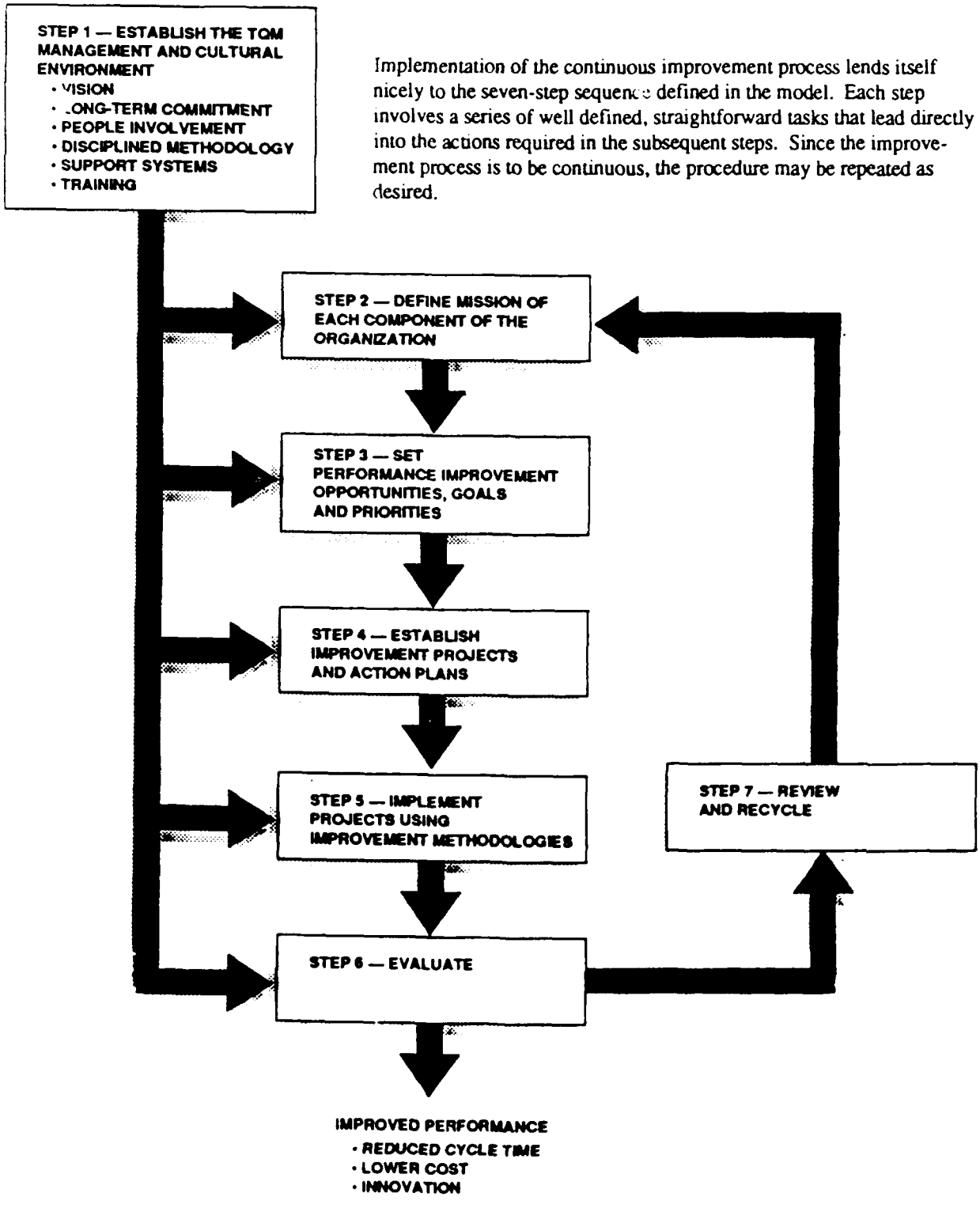
TQM is a focused management philosophy for providing the leadership, training, and motivation to continuously improve an organization's management and operations. What distinguishes TQM from other improvement strategies is its unflagging dedication to:

- ❑ Simultaneous improvement of technical performance while reducing cycle time and cost
- ❑ Recognition of quality as the presence of value, rather than just the absence of defects
- ❑ Focus on prevention rather than "find and fix"
- ❑ A working environment where all employees seek continuous improvement
- ❑ Organizational discipline to practice the new behaviors day after day, forever
- ❑ Cross-functional orientation and teamwork
- ❑ Focus on the product/service and the process
- ❑ Supplier-customer partnerships working on improvements.

These unique TQM activities are applied in conjunction with traditional management approaches, such as training, employee involvement, and quality awareness initiatives.

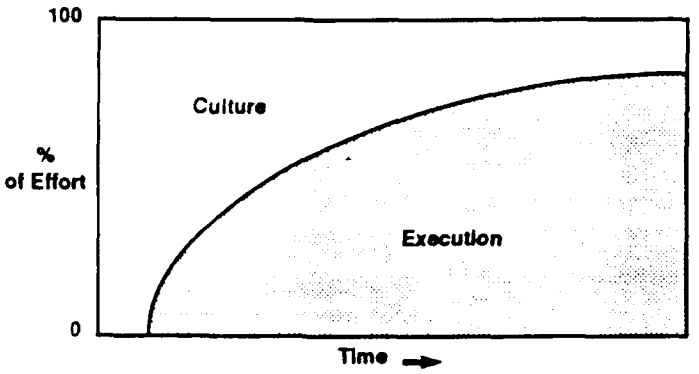
This guide provides a **seven-step sequential model** that will lead to continuous performance improvement. Subsequent pages provide information on using each of these steps.

Typical Total Quality Management Model



Implementation of the continuous improvement process lends itself nicely to the seven-step sequence defined in the model. Each step involves a series of well defined, straightforward tasks that lead directly into the actions required in the subsequent steps. Since the improvement process is to be continuous, the procedure may be repeated as desired.

Reference: Adapted from the Honeywell Aerospace and Defense Performance Improvement Guide.



Step 1: Establish the Management and Cultural Environment

Top Management Actions and Responsibilities

- ❑ Vision
- ❑ Long-Term Commitment
- ❑ People Involvement
- ❑ Disciplined Methodology
- ❑ Support Systems
- ❑ Training.

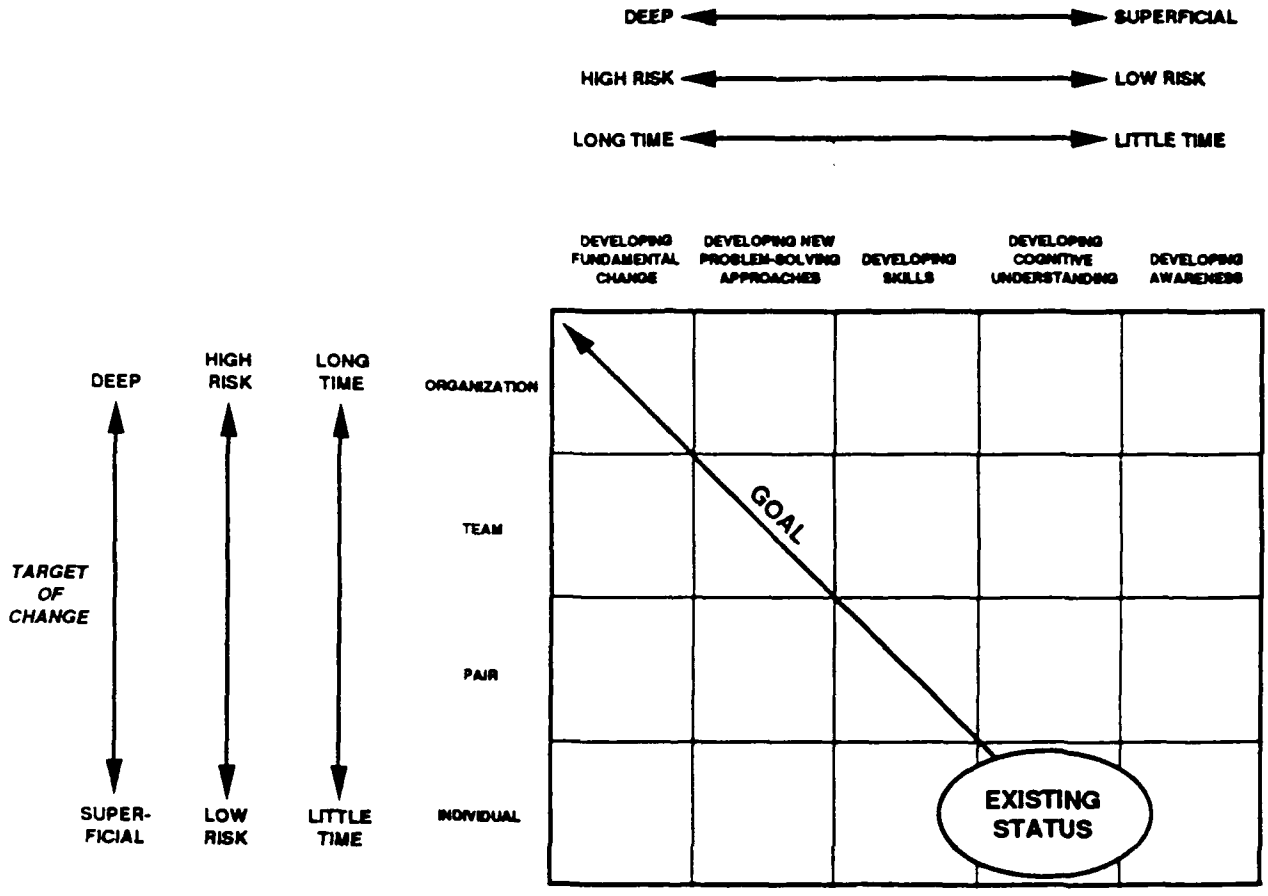
The TQM process is a total organizational approach toward continuous improvement of products and services. TQM requires management to exercise the leadership to establish the conditions for the process to flourish.

Management creates a new, more flexible environment and culture that will encourage and accept change. The new culture is developed and sustained so that all the people, working together, can maximize their contribution as individuals to the organization's objective of excellence.

Management accepts the up-front investment and the prolonged gestation period before the new systems become alive and productive.

Change in personal behavior is generally difficult because it goes against the very values we have learned in our respective organizations. Some of the changes required are as simple as the idea that the customer sets the requirements. In an organization that is used to having the person with the most authority tell people what is wanted, the change to a customer-driven organization is a very tough one. The exhibits on the next pages provide a conceptual roadmap for cultural change and some specific examples of this change.

A Roadmap to Cultural Change



Reference: Adapted from the Tichy Development Model, Noel M. Tichy, Univ. Of Michigan

Examples of Cultural Changes Required

CATEGORY	PREVIOUS STATE	NEW CULTURE
Mission	Maximum return on investment/management by objectives (ROI/MBO)	Ethical behavior and customer satisfaction. Climate for continuous improvement. ROI a performance measure
Customer Requirements	Incomplete or ambiguous understanding of customer requirements	Use of a systematic approach to seek out, understand, and satisfy both internal and external customer requirements
Suppliers	Unidirectional relationship	Partnership
Objectives	Orientation to short-term objectives and actions with limited long-term perspective	Deliberate balance of long-term goals with successive short-term objectives
Improvement	Acceptance of process variability and subsequent corrective action assigning blame as the norm	Understanding and continually improving the process
Problem-Solving	Unstructured individualistic problem-solving and decision-making	Predominantly participative and interdisciplinary problem-solving and decision-making based on substantive data
Jobs and People	Functional, narrow scope management-controlled	Management and employee involvement; work teams; integrated functions
Management Style	Management style with uncertain objectives that instills fear of failure	Open style with clear and consistent objectives, which encourages group-derived continuous improvement
Role of manager	Plan, organize, assign, control, and enforce	Communicate, consult, delegate, coach, mentor, remove barriers, and establish trust
Rewards and recognition	Pay by job. Few team incentives	Individual and group recognition and rewards, negotiated criteria
Measurement	Orientation toward data-gathering for problem identification	Data used to understand and continuously improve processes

1.1 Vision

Management creates the vision of what the organization wants to be and where it wants to go. This vision reflects the values of the organization and should be unencumbered by current constraints and/or systems—creative thinking is critical.

Guidance:

The organization needs to know of its current position before it determines where it wants to go. Benchmarking is a tool that will:

— Construct a picture of the way key processes are performing with respect to quality, productivity, and workforce involvement,

— Determine strengths and weaknesses relative to "best in class"

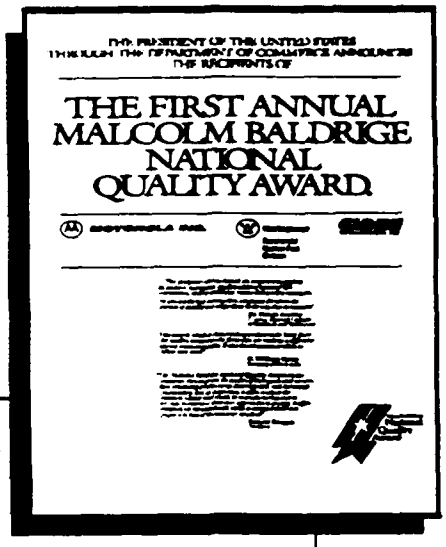
— Set the course for the future, and

— Provide a baseline for measuring progress.

Benchmarking is a continuous process of comparing an organization's products, services, and processes to their toughest competitors or those known as leaders in their fields. Such data can be used to improve their own standards of performance. The premise is that it is better to use performance of others as a measure instead of relying solely on evaluating internal results. The goal of benchmarking is to find out the "**best of class**" processes for performing a particular job, and then to adopt those processes to internal needs.

The annual **Malcolm Baldrige Award**, and the criteria used to evalute an organization's performance on which it is based, may be used as one set of yardsticks to measure the validity and the impact of a continuous improvement effort.

Companies with a Vision



Malcolm Baldrige Award Criteria:

- **Leadership**–The senior management's success in creating and sustaining a quality culture.
- **Information and Analysis**–The effectiveness of the company's collection and analysis of information for quality improvement and planning.
- **Planning**–The effectiveness of integration of quality requirements into the company's business plans.
- **Human Resource Utilization**–The success of the company's efforts to utilize the full potential of the work force for quality.
- **Quality Assurance**–The effectiveness of the company's systems for assuring quality control of all operations.
- **Quality Assurance Results**–The company's results in quality achievement and quality improvement, demonstrated through quantitative measures.
- **Customer Satisfaction**–The effectiveness of the company's systems to determine customer requirements and demonstrated success in meeting them.

The matrix on the next page provides a benchmarking guide. This matrix, or one of your own, can be used to assess the progress of your organization in implementing TQM.

TQM CATEGORY		TOP-MANAGEMENT COMMITMENT	OBSESSION WITH EXCELLENCE	ORGANIZATION IS CUSTOMER-DRIVEN	CUSTOMER SATISFACTION	TRAINING	EMPLOYEE INVOLVEMENT	USE OF INCENTIVES	USE OF TOOLS
STANDING ⟶ DESIRED DIRECTION	5	CONTINUOUS IMPROVEMENT IS A NATURAL BEHAVIOR EVEN DURING ROUTINE TASKS	CONSTANT, RELATIVE IMPROVEMENT IN QUALITY, COST, AND PRODUCTIVITY	CUSTOMER SATISFACTION IS THE PRIMARY GOAL	MORE CUSTOMERS STATE INTENTION TO MAINTAIN LONG-TERM BUSINESS RELATIONSHIP	TRAINING IN TQM TOOLS COMMON AMONG ALL EMPLOYEES	PEOPLE INVOLVEMENT: SELF DIRECTING WORK GROUPS	GAINSHARING (CROSS-FUNCTIONAL TEAMS)	STATISTICS IS A COMMON LANGUAGE AMONG ALL EMPLOYEES
	4	FOCUS IS ON IMPROVING THE SYSTEM	USE OF CROSS-FUNCTIONAL IMPROVEMENT TEAMS	CUSTOMER FEEDBACK USED IN DECISION-MAKING	STRIVING TO IMPROVE VALUE TO CUSTOMERS IS A ROUTINE BEHAVIOR	TOP MANAGEMENT UNDERSTANDS AND APPLIES TQM PHILOSOPHY	MANAGER DEFINES LIMITS; ASKS GROUP TO MAKE DECISION	MORE TEAM THAN INDIVIDUAL INCENTIVES AND REWARDS	DESIGN AND OTHER DEPARTMENTS USE SPC TECHNIQUES
	3	ADEQUATE MONEY AND TIME ALLOCATED TO CONTINUOUS IMPROVEMENT AND TRAINING	TQM SUPPORT SYSTEM SET UP AND IN USE	TOOLS USED TO INCLUDE WANTS AND NEEDS IN DESIGN	POSITIVE CUSTOMER FEEDBACK; COMPLAINTS USED TO IMPROVE	ONGOING TRAINING PROGRAMS	MANAGER PRESENTS PROBLEM, GETS SUGGESTIONS, MAKES DECISION	QUALITY-RELATED EMPLOYEE SELECTIONS AND PROMOTION *CRITERIA*	SPC* USED FOR VARIATION REDUCTION
	2	BALANCE OF LONG-TERM GOALS WITH SHORT-TERM OBJECTIVES	EXECUTIVE STEERING COMMITTEE SET UP	CUSTOMER NEEDS AND WANTS ARE KNOWN	CUSTOMER RATING OF COMPANY IS KNOWN	TRAINING PLAN DEVELOPED	MANAGER PRESENTS IDEAS AND INVITES QUESTIONS, MAKES DECISION	EFFECTIVE EMPLOYEE SUGGESTION PROGRAM USED	SPC* USED IN MANUFACTURING
	1	TRADITIONAL APPROACH TO QUALITY CONTROL – INSPECTION IS PRIMARY TOOL (CONTROL OF DEFECTS, NOT PREVENTION) – BETTER QUALITY = HIGHER COST – SIGNIFICANT SCRAP AND REWORK ACTIVITY – QUALITY CONTROL FOUND ONLY IN MANUFACTURING DEPARTMENTS MBO IMPROPERLY USED FOR ALL DEPARTMENTS							

*SPC USED AS AN EXAMPLE

AN EXAMPLE OF A GUIDE TO ASSESS STATUS OF TQM IMPLEMENTATION
(Develop one to suit your own needs)

1.2 Long-Term Commitment

Management demonstrates a long-term commitment to implement improvement, even when improvement may be difficult or perceived to have high front-end costs.

Guidance:

Commitment entails more than new policies, directives, letters, and speeches. The workforce judges commitment of top management by the behaviors they exhibit.

A leader demonstrates the kind of behavior that very strictly supports TQM. Management has been saying the right words for decades. People have learned, however, that management frequently does not match their lips with their feet; and over time, have lost some confidence in management's ability to do what it says. They will be convinced when management visibly commits through tangible actions to error-free work, management by prevention, and meeting customer requirements.

Management provides the leadership to:

— Maintain a long-term perspective in the face of short-term pressures

— Recognize that the transition to a total quality culture will occur over an extended period of time. Some results will be immediate, but others may take 10 years or more to achieve

— Fund and staff to support TQM training and implementation

— Institute compensation and/or recognition programs based on TQM-based goals

— Encourage employee involvement

— Drive out fear so that everyone may work effectively

— Promote timely training

— Reward expected behavior.

1.3 People Involvement

Management actively involves all people in the improvement process; encourages and empowers people to create ideas and make decisions within their area of expertise not only to do the work, but also to improve the system.

Guidance:

The ultimate objective is to empower the workforce to exercise self-direction while continuously pursuing improvement strategies in routine work as well as on special projects. This objective cannot be accomplished overnight but can be implemented over time according to a phased process that considers the existing organization structure and philosophy, information flow, and the reward structure.

The three stages of people involvement are:

- participation
- involvement
- empowerment.

The matrix on the next page provides a basis for understanding the continuum from participation to empowerment. The critical element is the degree of decision power.

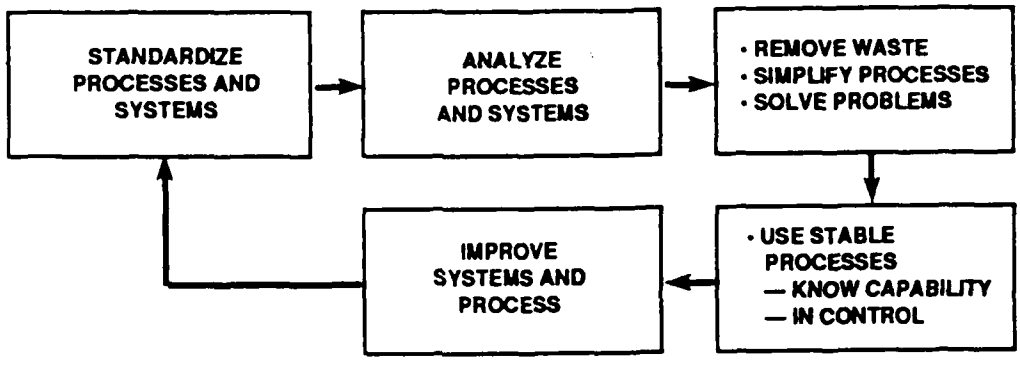
Stages of People Involvement

	PARTICIPATION	INVOLVEMENT	EMPOWERMENT
ORGANIZATIONAL STRUCTURE	HIERARCHICAL	HIERARCHICAL AND AD HOC TEAMS	CUSTOMER-FOCUSED, AUTONOMOUS WORK TEAMS
TYPICAL IMPROVEMENT EFFORTS	SUGGESTION PROGRAM WORK MEASUREMENT QUALITY CIRCLES	AD HOC TEAMS WORK ON PROBLEMS	TEAMS CONSISTENTLY ANALYZE AND IMPROVE PROCESSES
DECISION POWER	TOP DOWN	RECOMMEND CHANGES LIMITED TEAM-BASED DECISION-MAKING	MAKE PROCESS-RELATED DECISIONS INPUT INTO STRATEGIC DECISIONS
GAINSHARING	APPROVED SUGGESTIONS INDIVIDUAL WORK PERFORMANCE	SOME TEAM/UNIT PARTICIPATION AND RECOGNITION	TEAM RECOGNITION e.g., GAINSHARING
MANAGEMENT FOCUS	SUPERVISING	COACHING	CREATING ENVIRONMENT FOR TEAMWORK

1.4 Disciplined Methodology

Management uses a disciplined approach involving the appropriate tools to achieve continuous improvement. Persistent, disciplined application of continuous improvement methodology is a must.

Persistence Pays



Knowing what TQM is and knowing what tools and techniques are available are necessary for success, but not sufficient for achieving it. No matter how good the systems and processes are, they will be of marginal value unless people use them in a disciplined manner. Having the discipline to work on TQM day after day so it becomes a new way of life is the key factor for success. Specifically, the creation of a disciplined environment will enable:

— Consistent application and use

— Removal of ambiguity

— Compatibility among departments, functions, projects, etc.

A disciplined approach seems deceptively simple to achieve, but it is exceedingly difficult to execute. For example, most people know that personal fitness can be maintained by proper eating habits and exercise, but they cannot maintain the discipline required for well-being in their daily lives. Rather, people try various fads and "quick fixes," unfortunately, in cycles that leave them in worse shape than before.

(Continued on next page)

Organizations exhibit the same type of behavior. Various fads and programs may show early success but, ultimately, result in failure and a growing cynicism about future efforts.

There is no substitute for the day-to-day discipline and tools of continuous improvement needed to reinforce TQM.

You will know you lack discipline when:

- — Any part of the process begins to lag or becomes delinquent
- — Operating systems remain unchanged
- — Authority and responsibility structure remains unaltered
- — Assumptions concerning the role of people are not challenged
- — Little consistency or continuity of purpose is exhibited toward seeking more efficient ways to meet and exceed customer needs
- — Day-to-day behaviors remain unchanged.

Don't institute a new behavior that can't be maintained and improved forever!

1.5 Support Systems

Management ensures that an adequate supporting structure is in place.

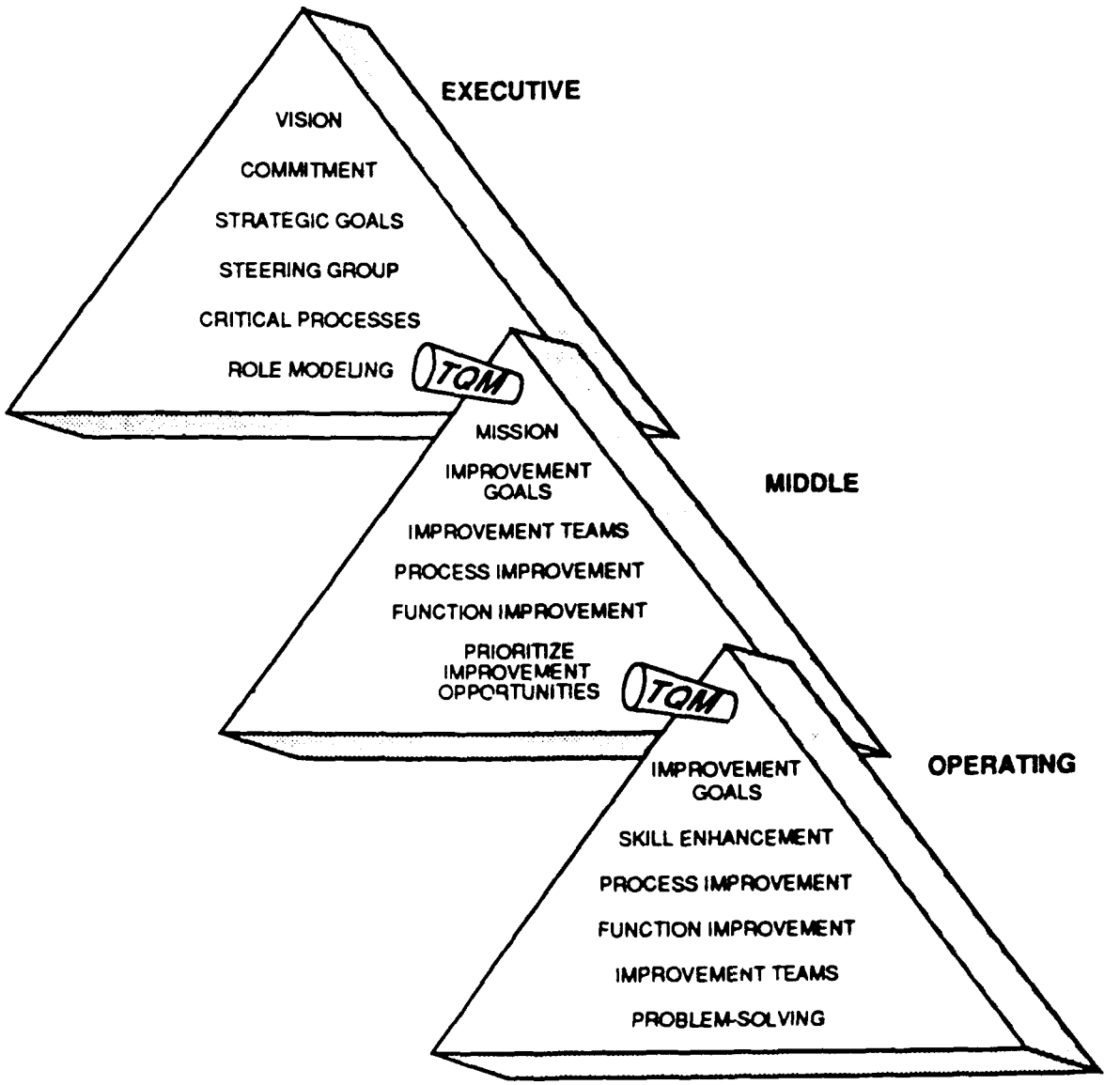
Guidance:

An approach to implementation is to begin the improvement process with senior management and subsequently cascade the goals, values, structure, and training established and adopted at upper levels to succeeding levels. Each level is linked to the other by the common objective of making people capable of joint performance. The support model on the following page provides an example of these relationships.

Initially, it is helpful to establish an executive-level steering group and TQM support structure for the overall effort. Eventually, as the TQM philosophy becomes a natural behavior exhibited in routine work, special support structures can be modified and blended into the organization. (See Step 4 for additional information.)

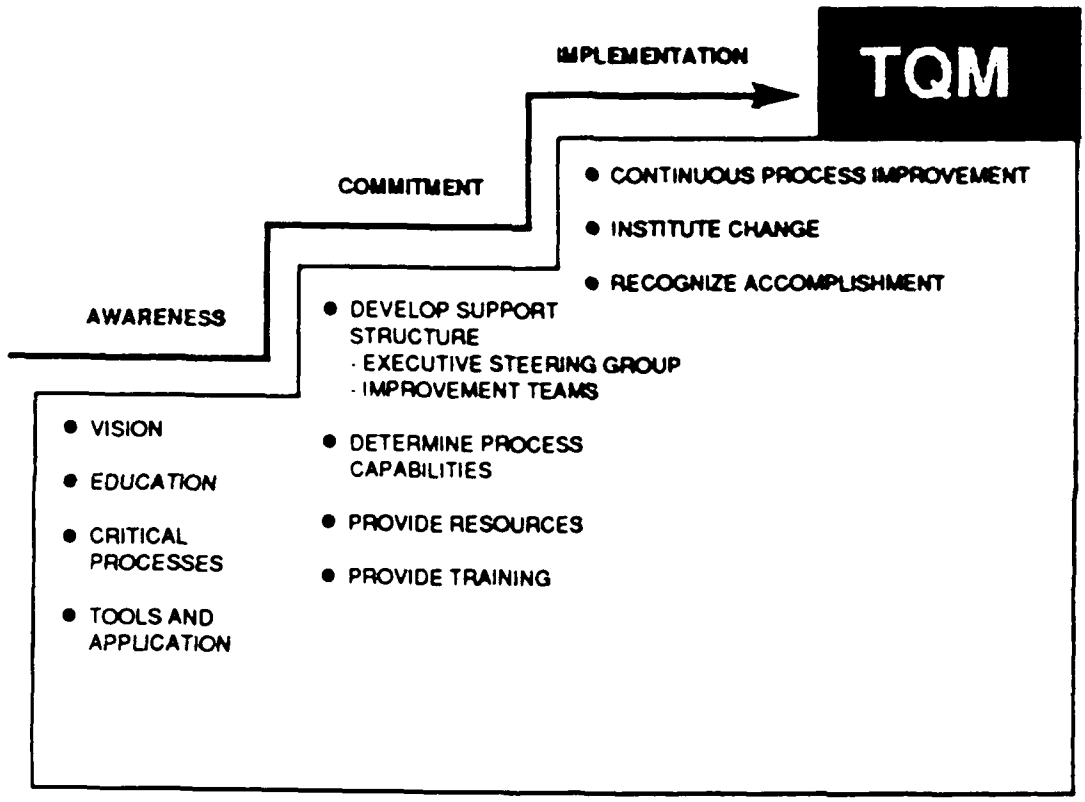
TQM Supports the Manager as a Link Pin to Tie the Organization Together in the Pursuit of Excellence

An Example of a Support Model



Reference: Adapted from The Cumberland Group's Organizational Effectiveness Model

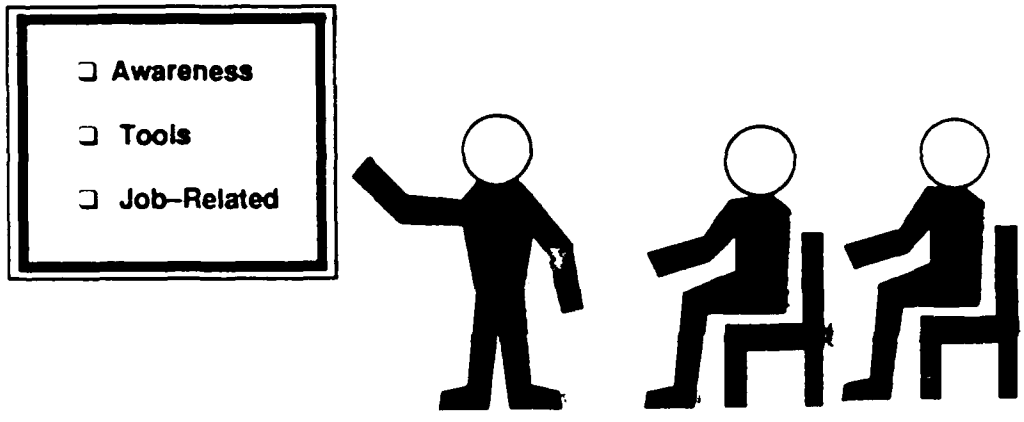
The Process of Getting Started
(Steps up the ladder to TQM)



1.6 Training

Management makes all employees aware of the need for and the benefits of TQM, and trains them in the use of tools and techniques to support continuous improvement. Scope and intensity of training will depend on such factors as organization level, nature of work, and specific processes under review for improvement.

Guidance:



The implementation of continuous improvement requires an integrated education, training, and development strategy. When expectations of employees are changing, it is important to communicate clearly and effectively to help avoid counter–productive reactions.

Through training, employees are equipped with:

— The tools for self–monitoring and self–correction leading to continuous improvement

— The rewards/satisfaction of applying the new concept or process effectively, and in most cases, immediately

— The understanding and resulting motivation to keep applying the new concept or process effectively into the future.

(Continued on the next page)

Training should be tailored to support the vision and goals set by top management. Additionally, training should be continuously evaluated for effectiveness.

Common mistakes are to:

— Conduct mass training before support systems for TQM have been set up

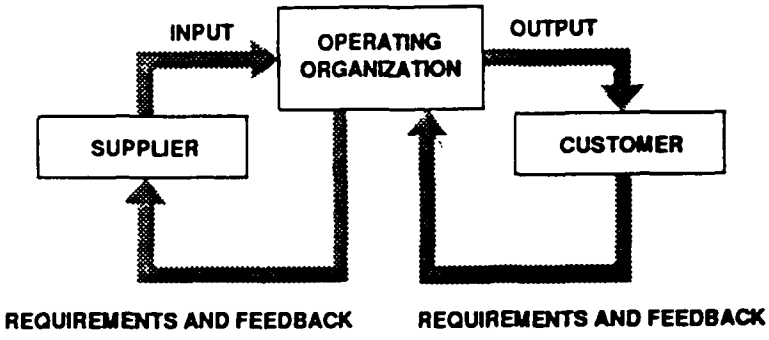
— Overemphasize the technical tools at the expense of leadership and management issues

— Oversimplify and underestimate the difficulty of transitioning the commercial application of TQM to the defense environment

— Apply the tools before the needs are determined.

Step 2: Define the Mission

Model Showing feedback loops between the operating group and its customers and suppliers



Everyone has a customer (internal and external), and TQM concentrates on providing customers with services and products that consistently meet their needs and expectations.

Every member of the organization must know the purpose of his job, his customer(s), and his relation to others in the organization for providing customer satisfaction.

Everyone must know his customer's requirements. Everyone must also make his suppliers aware of those, and other requirements. Be aware that customers and suppliers can be anything from another organization to a co-worker.

(Continued on the next page)

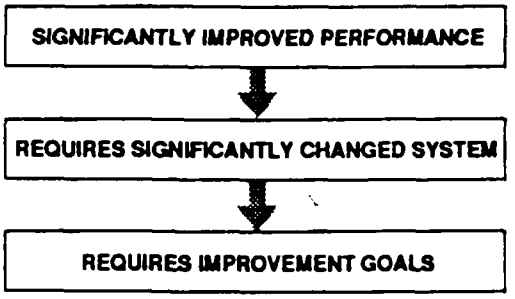
The mission of each element of an organization must reflect a perspective that, when combined with other elements of the organization, will provide the synergy that produces TQM.

Follow these steps to define your mission:

1. Identify the customer(s) you serve (do not forget internal customers).
2. Identify the requirements of your customer(s).
3. Identify the processes and resources used to satisfy the requirement.
4. Identify the products or services you provide to meet these requirements.
5. Develop measures of your output that reflect customer requirements.
6. Review the preceding steps with your customer and adjust them as necessary.
7. Identify your principal inputs (labor, materials, products, services, etc.).
8. Involve your suppliers in the development of your requirements and their conformance to them.
9. Finally, define your mission with respect to the steps above. If the result does not match your current job description, your job description needs to be changed to reflect your mission. You also need to check policies, procedures, work instructions, and other documents that influence your job.

Step 3: Set Performance Improvement Goals

Improved performance requires improvement goals. Both involve change.



Steps 1 and 2 of the TQM model determined where the organization wants to go, how it is now performing, and what role each member will play in achieving organizational performance. Step 3 sets the goals for performance improvement. These goals must reflect an understanding of the process capabilities of the organization so that realistic goals can be set. Some organizations set strategic "stretch goals" to encourage and focus on significant improvement. For example, Motorola has set a goal for process capability at the 6 σ level.

The goals should first be set at the senior-management level. They should reflect strategic choices about the critical processes and customer desires in which success is essential to organizational survival.

The above is driven by providing value to the customer (internal and/or external).

Middle and line management set both functional and process improvement goals to achieve the strategic goals set by senior management. The hierarchy of goals establishes an architecture that links improvement efforts across the boundaries of the functional organization. Within functional organizations, performance improvement teams provide cross-functional orientation, and the employees on these teams become involved in process issues. Thus, the entire organization is effectively interlinked to form an ideal performance improvement setting.

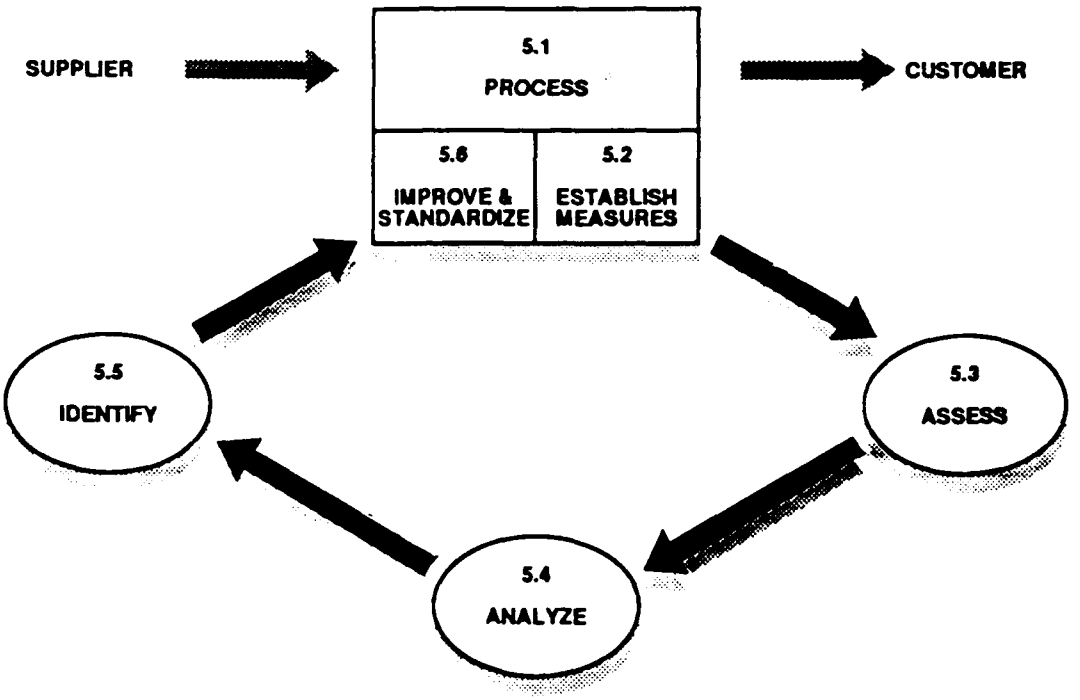
Step 4: Establish Improvement Projects and Action Plans

The goals developed in Step 3 are cascaded from the executive level to operations. To implement these goals, the activities of the groups and teams established in Step 1 are provided below.

Steering Group	Improvement Teams	Problem-Solving Teams
• Develop philosophy, constancy of purpose, and guiding principles. • Focus on critical processes that affect customer satisfaction and/or major cost waste. • Identify an "owner" of each critical process. • Resolve organizational and functional barriers. • Provide resources, training, and rewards. • Establish criteria for measuring outputs/customer requirements. • Measure progress vs. goals.	• Set task goals (allocated down to processes from top-level goals). • Conduct system and process analysis. • Select problem-solving teams. • Train teams. • Develop improvement plans, methodology, and metrics to measure progress vs. goals • Track and report progress and provide help if necessary. • Train and provide facilitators to support performance improvement teams. • Characterize the capability of the process and continuously improve it. • Apply a structured performance improvement methodology (See step 5 for additional information).	• Apply a structured performance improvement methodology (See step 5).

Step 5: Implement Projects with Performance Tools and Methodologies

Basic Performance Improvement Cycle

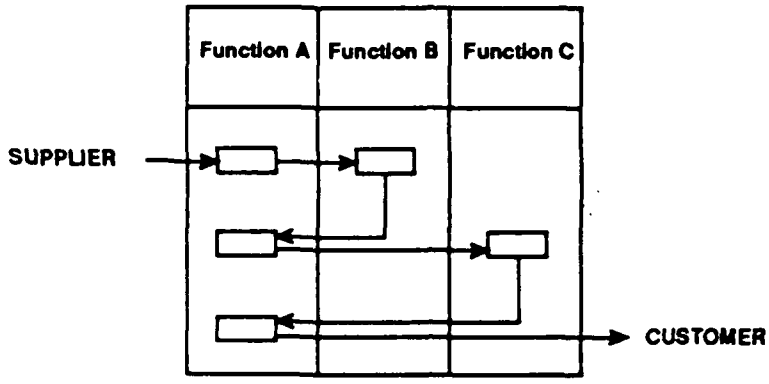


The analysis and improvement of a process relies on a structured approach, such as the performence improvement cycle shown above. The following pages describe the steps of this cyclic improvement process. Tools referenced here are defined in succeeding sections.

Reference: This section on Tools & Techniques was adapted from AT&T's Process Quality Management and Improvement Guidelines.

5.1 Define Process, Identify Customer and Supplier Requirements

Typical Flow Diagram (Input–Output)



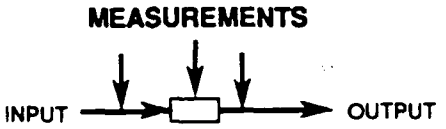
Suggested Approach to Analyzing a Customer Requirement

OBJECTIVES	KEY ACTIVITIES	TOOLS/ APPROACHES
• Understand the process and what is required of it. • Identify the process owner. • Identify the role of process members.	• Define process boundaries, outputs and customers, inputs and suppliers, and major processes and flows. • Identify process owner and process members. • Define customer and supplier requirements. • Identify to customers changes to requirements that promote performance improvement.	• Nominal Group Technique (NGT) • Block Diagram/Flow Diagram • Input/Output Analysis • Benchmarking • Acquisition Streamlining * • Could Cost * • Quality Function Deployment

* DoD Acquisition Initiatives

5.2 Develop and Establish Measures

All components of the process are subject to measurement.

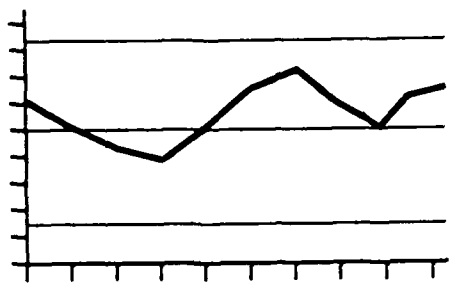


OBJECTIVES	KEY ACTIVITIES	TOOLS/ APPROACHES
• Determine measurements needed to understand and improve the process.	• Determine how to measure performance with respect to customer requirements. • Determine additional data to manage the process. • Establish regular feedback with customers and suppliers. • Measure quality/cost/ timeliness of inputs. • Measure quality/cost/ timeliness of output.	• Nominal Group Technique (NGT) • Design to Production * Transition Templates • Quality Function Deployment • Statistical Methods

* DoD Acquisition Initiative

5.3 Assess Conformance to Customer Needs

The variations can be plotted, analyzed, and minimized.

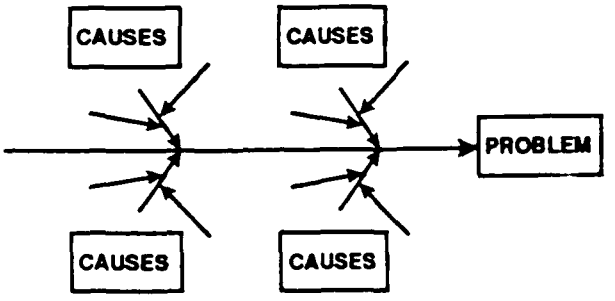


OBJECTIVES	KEY ACTIVITIES	TOOLS/ APPROACHES
• Assess both customer and supplier requirements. • Separate special causes from common causes.	• Collect and review significant data that defines the process. • Identify and remove special causes of variation. • Identify common problem areas.	• Statistical Methods • Inspection • User Feedback • $(CP)^2$ * • Exemplary Facilities * • R&M 2000 *

* DoD Acquisition Initiatives

5. 4 Analyze Improvement Opportunities

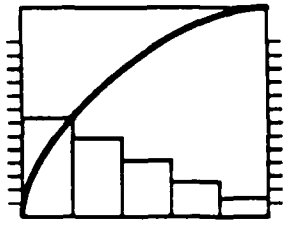
Typical "fishbone" presentation of the major and minor causes of a problem.



OBJECTIVES	KEY ACTIVITIES	TOOLS/ APPROACHES
• Analyze process improvement opportunities. • Eliminate non-value-added steps and simplify.	• Gather data. • Identify potential process improvement areas. • Document.	• Nominal Group Technique (NGT) • Cause and Effect Analysis • Work Flow Analysis • Input/Output Analysis • Statistical Methods

5.5 Identify and Rank Improvement Opportunities

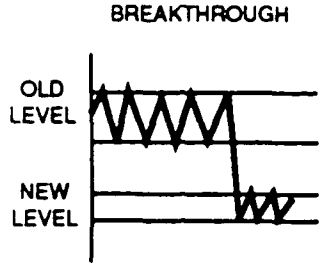
A Pareto chart used to help set priorities for improvement actions



OBJECTIVES	KEY ACTIVITIES	TOOLS/ APPROACHES
• Decide on priorities. • Set improvement goals.	• Review improvement opportunities. • Identify improvement projects and decide which ones should be worked on first.	• Pareto Diagram • Nominal Group Technique (NGT) • Cost of Quality

5.6 Improve Process Quality

A major benefit of the improvement process is the reduction of the magnitude and range of variation.



OBJECTIVES	KEY ACTIVITIES	TOOLS/ APPROACHES
• Achieve improved level of process performance.	• Develop action plan. • Identify root causes. • Test and implement solution. • Standardize the improved process to hold gains. • Conduct periodic review of progress.	• Statistical Methods • Design of Experiments • Variation Reduction • Robust Design • Design to Production * Templates

* DoD Acquisition Initiative

Step 6: Evaluate

- ❑ Process Measurement
- ❑ Project Measurement
- ❑ Behavioral Change Measurement
- ❑ Quality Loss Function

Measurement, evaluation, and reporting are essential elements of the continuous improvement process. They focus on the effectiveness of improvement efforts and identify areas for future improvement efforts. All levels of management are involved in this process.

A basic need in all improvement efforts is the ability to measure the value of the improvement in units that are pertinent and meaningful to the specific task. For example, one evaluation of the "before" and "after" levels of customer satisfaction following an improvement effort might include the number of customer complaints. In evaluating behavioral changes, one might measure and compare employee turnover rate, or the number of grievances filed in a month. Other meaningful yardsticks might be dollars of cost, units per hour, rejects per lot, and cycle time.

❑ Process Measurements

These measurements track the performance of a process with respect to:

- — Internal customers (next operation)
- — External customers (ultimate customer).

(Continued on the next page)

Most organizations have existing measures that may be used "as is" or modified as necessary. There is no menu of measurements applicable to all users. The key is to select measures that can be used by work units to manage and evaluate their products and services so that continuous process improvement can be undertaken. Measurements should address both effectiveness and efficiency of processes. (Effectiveness — doing the right things; Efficiency — doing things right)

❑ Project Measurements

A performance improvement team should develop measures that are appropriate for their continuous process improvement project.

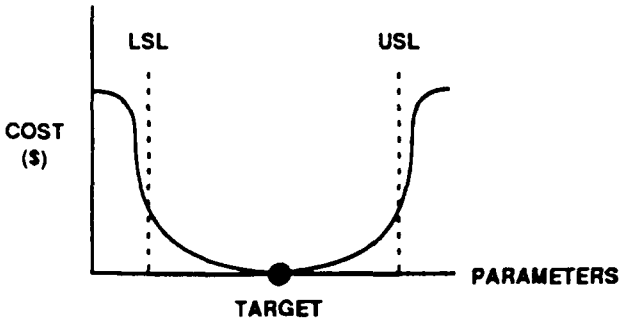
❑ Behavioral Change Measurement

There should be observable, consistent evidence of the following:

1. Management support for continuous improvement
2. Trust between management and employees
3. Open communications without fear
4. Involvement of all employees
5. Teamwork
6. Supporting salary and reward system
7. Short-term issues do not overpower the long-run issues
8. Process, rather than functional orientation
9. Knowledge and skills of TQM
10. Availability of time and resources for TQM
11. Employee support for TQM

(Continued on the next page)

❑ Quality Loss Function



From an engineering perspective, cost of quality can also be viewed as the losses that are caused by a product's functional parameters deviating from its desired target value.

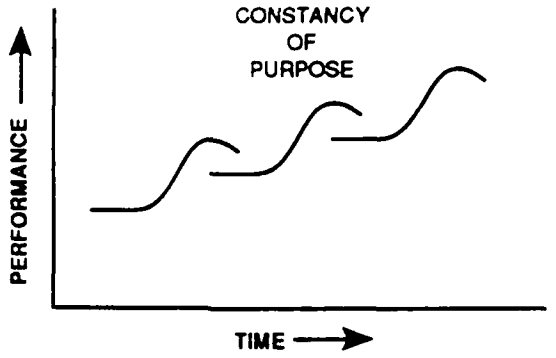
A significant philosophical point is that cost of quality increases, not only when the product is outside of specifications, but also when the product falls within specifications but deviates from target values. These costs continually increase as the product deviates further from the target value.

Examples of cost factors are:

- Inspection costs
- Rejects, scrap, rework
- Lowered reliability due to tolerance build-up
- Higher warranty costs
- Less customer satisfaction.

The engineering objective is to reduce costs by decreasing variability around target values. The **concurrent engineering** approach is one way to do this.

Step 7: Review and Recycle



Most human efforts go through the three phases of **Beginning–Growth–Fading Out**. It is necessary to perpetuate the continuous improvement process forever (lifetime). Approaches to TQM tend to have a limited survival (cycle) and, if left unattended, will become ineffective. Quality circles are an example.

All employees will need to review progress with respect to improvement efforts and modify or rejuvenate existing approaches for the next progression of methods. **Quality circles** may evolve into **autonomous work teams. Suggestion awards** may evolve into **gainsharing. Statistical process control** may evolve into **variability reduction**.

This constant evolution reinforces the idea that **TQM is not a program** but a new day-to-day behavior for each member of the organization.

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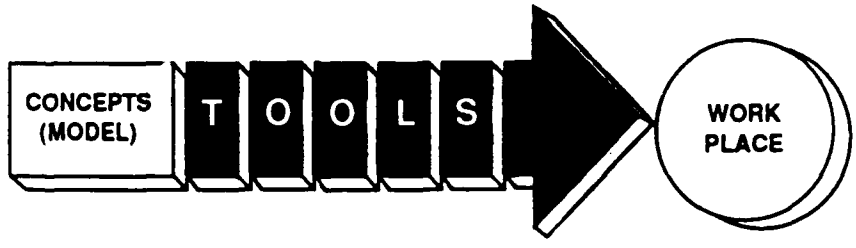
Tools and Techniques

TOOLS AND TECHNIQUES OF TOTAL QUALITY MANAGEMENT



This section provides additional guidance on the use of the generic tools and techniques that were identified in the performance improvement model. They are representative of the tools that are used to improve any process and are presented in this section to provide an awareness of what they are, why they are used, and how to use them. Not all tools are appropriate for use in all applications. Other sources should be consulted to obtain in-depth information concerning content and use.

If your only tool is a hammer,
everything looks like a nail.

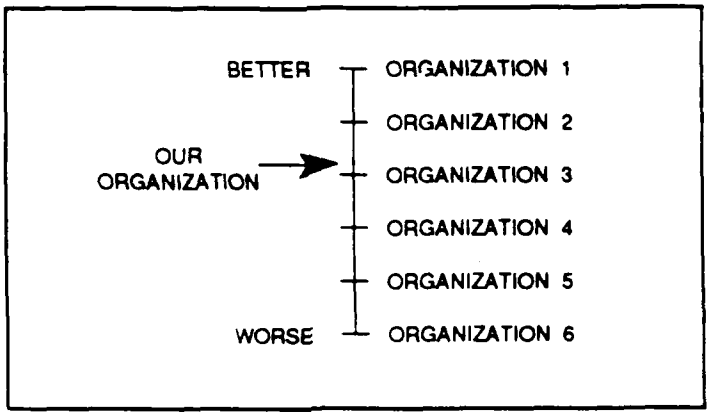
Overview of TQM Tools

There are a number of factors that may lead to the desision for using a particular tool or set of tools, including an individual's/team's experience and preferences. Most tools are oriented to a certain type of activity, and all tools have their specific strengths and weaknesses. This section summarizes some of the common tools used in the process of implementing TQM.

Some of the common tools used in the process of implementing TQM.

TOOLS & TECHNIQUES (Listed without regard to priority)	PROBLEM - SOLVING ACTIVITIES					
	1. Bounds & Prioritize Problems	2. Compile Information	3. Analysis	4. General Alternatives	5. Evaluate	6. Plan & Implement
Benchmarking	✓	✓	✓		✓	
Cause & Effect Diagrams	✓		✓			
Nominal Group Technique	✓	✓		✓	✓	✓
Quality Function Deployment	✓		✓		✓	
Pareto Charts	✓	✓	✓			
Statistical Process Control		✓	✓			
Histograms		✓	✓			
Check Sheets		✓	✓			
Input/Output Analysis			✓			
Scatter Diagrams			✓			
Concurrent Engineering			✓	✓		
Design of Experiments			✓	✓	✓	
Cost of Quality			✓		✓	
Control Charts			✓		✓	
Work Flow Analysis			✓			✓
Team Building						✓
Time Management	✓					✓
Shewart Cycle	✓	✓	✓	✓	✓	✓

Benchmarking



What: Method of measuring your processes against those of recognized leaders. It helps you to establish priorities and targets leading to process improvement.

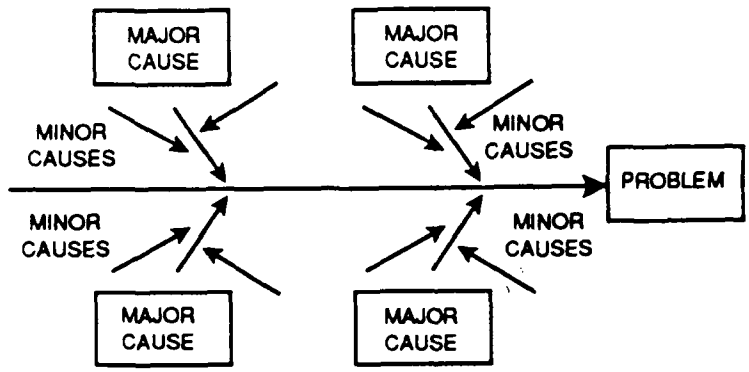
Why: When you know where you stand with respect to your competitors or other world-class operators, you can target various processes for improvement.

How:
1. Identify processes to benchmark and their key characteristics.
2. Determine who to benchmark: companies, organizations, or processes.
3. Determine benchmarks by collecting and analyzing data from direct contact, surveys, interviews, technical journals, and advertisements.
4. From each benchmark item identified, determine the **"best of class"** target.
5. Evaluate your process in terms of the benchmarks and set improvement goals.

One example: Use the Baldrige National Quality Award as a model for comparison.*

* Information can be obtained from:
U.S. Department of Commerce
National Institute of Standards and Technology
Gaithersburg, MD 20899
(301) 975-2036

Cause and Effect Diagrams



What: Represents the relationship between an effect (problem) and its potential causes.

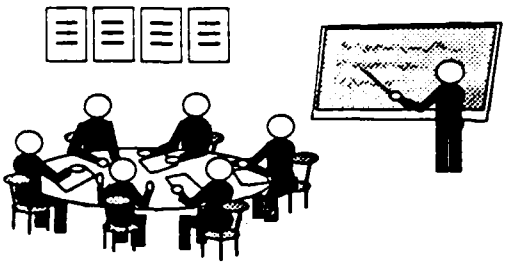
Why: The diagram is drawn to sort and relate the interactions among the factors affecting a process.

How:

1. Name the problem.
2. Decide the major categories of causes. Major causes may include: data and information systems, dollars, environment, hardware, materials, measurements, methods, people, and training.
3. Brainstorm for more detailed causes.
4. Eliminate causes that do not apply.
5. Discuss the remaining causes and decide which are most important.
6. Work on most important causes (e.g., use design of experiments).
7. Desensitize, eliminate, or control causes.

Reference: Wadsworth, Stephens and Godfrey. **Modern Methods for Quality Control and Improvement**, New York: John Wiley, 1986.

Nominal Group Technique (NGT)



What: A technique similar to brainstorming. A very structured approach to generate ideas and survey the opinions of a small (10-15) group.

Why: NGT produces many ideas/solutions in a short time. Structured to focus on problems, not people; to open lines of communication; to ensure participation; and to tolerate conflicting ideas. Builds consensus and commitment to the final result.

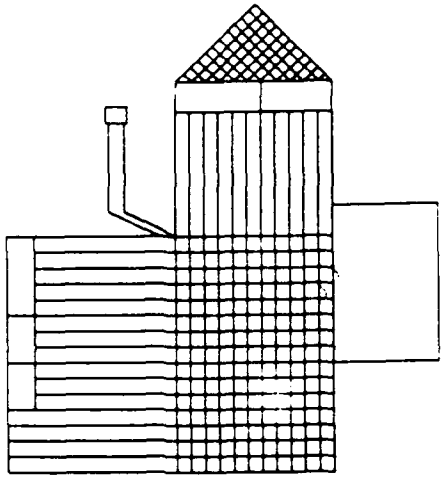
How:

1. Present issue, instructions.
2. Generate ideas, 5 to 10 minutes of quiet time, no discussion.
3. Gather ideas round robin, one idea at a time, written on flip chart and posted.
4. Process/clarify ideas-duplicates are eliminated, like ideas are combined. Limit discussion to brief explanations of logic or analysis of an item and brief agreement/disagreement statements. Focus on clarification of meaning, not arguing points.
5. Set priorities silently.
6. Tabulate votes.
7. Develop an action plan.

References: Delbecq, Van de Von and Gustafson. **Group Techniques for Program Planning**. Scott Foresman and Company, 1975.

Gregerman, Ira G. **Knowledge Worker Productivity**. New York: AMA Management Briefing, American Management Association, 1981, p. 55.

Quality Function Deployment (QFD)



What: A conceptual map that provides the means for cross-functional planning and communications. A method for transforming customer wants and needs into quantitative, engineering terms.

Why: Products should be designed to meet customer wants and needs so that customers will buy products and services, and continue to buy them. Marketing people, design engineers, manufacturing engineers, and procurement specialists work closely together from the time a product/service is first conceived to be able to meet customer requirements. **QFD** provides the framework for the cross-functional teams to work within.

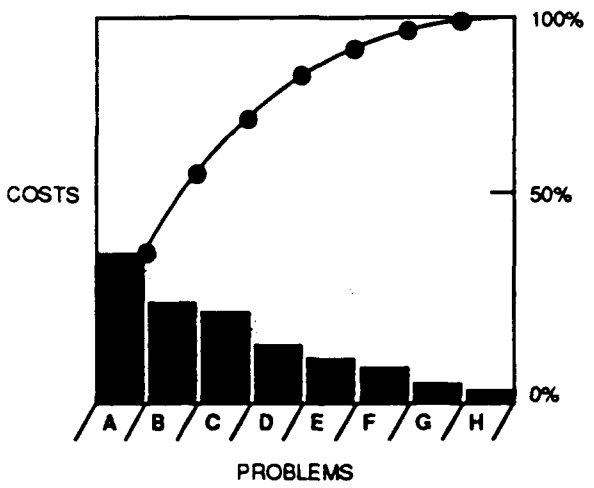
How: Ask these questions:

- — What do customers want (attributes)?
- — Are all preferences equally important?
- — Will delivering perceived needs yield a competitive advantage?
- — What are the engineering characteristics that match customers' attributes?
- — How does each engineering characteristic affect each customer attribute?
- — How does one engineering change affect other characteristics?

References: Hauser, John R. and Clausing, Don. **House of Quality**, Harvard Business Review, May-June, 1988, pp 63-73.

King, Bob. **Better Quality in Half the Time**, Goal/QPC, Methuen, MA, 1987.

Pareto Charts



What: A bar chart in which the bars are arranged in descending order, with the largest to the left. Each bar represents a problem. The chart displays the relative contribution of each sub–problem to the total problem.

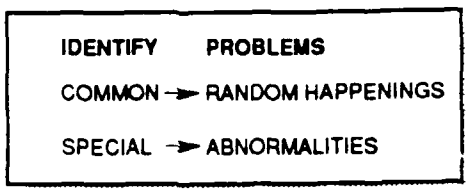
Why: This technique is based on the **Pareto principle**, which states a few of the **problems** often account for most of the effect. The Pareto chart makes clear which "vital few" problems should be addressed first.

How:

1. List all elements of interest.
2. Measure the elements, using the same unit of measurement for each element.
3. Order the elements according to their measure, not their classification.
4. Create a cumulative distribution for the number of items and elements measured and make a bar and line graph.
5. Work on the most important elements first.

Reference: Wadsworth, Stephens and Godfrey. **Modern Methods for Quality Control and Improvement**, New York: John Wiley, 1986.

Statistical Process Control (SPC)



What: Method for determining the cause of variation based on a statistical analysis of the problem. **SPC** uses probability theory to control and improve processes.

Why: **SPC** is an effective tool for improving performance of any process. It helps identify problems quickly and accurately. It also provides quantifiable data for analysis, provides a reference baseline, and promotes participation and decision-making by people doing the job.

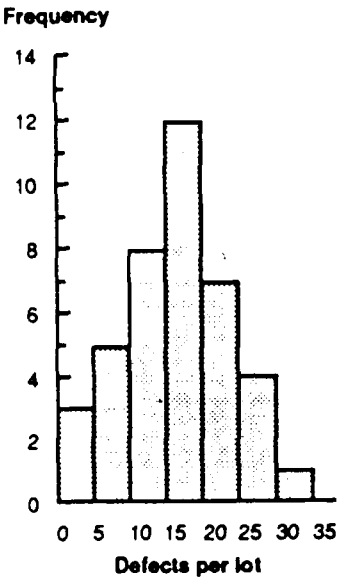
How:

1. Identify problems or performance improvement areas. Identify common and special causes. Common causes are random in nature, often minor. Special causes result from an abnormality in the system that prevents the process from becoming stable.
2. Do a cause and effect analysis.
3. Collect data.
4. Apply statistical techniques (may need a statistical specialist).
5. Analyze variations.
6. Take corrective action.

References: Deming, W.E. **Quality, Productivity, and Competitive Position,** Circle Advanced Engineering Studies, 1983.

Stewart, Walter. **Economic Control of Manufactured Product,** 1980, p. 501.

Histograms



What: A graph that displays frequency of data in column form.

Why: Help to identify changes or shifts in processes as changes are made. It shows how variable measurements of a process or product can be, and it helps in the establishment of standards. Once standards have been set, measurements can be compared to these standards.

How:

1. Determine measurements to be taken.
2. Collect data.
3. Organize data into incremental units.
4. Develop a graph to pictorially summarize results.

Checksheets

Checksheet

Product: Receiver unit XYZ

DATE: 9/09/89

Name: Smith

Lot: 17

Total examined: 200

Defect type	Defect count	Subtotal
Chipped	𝍸 𝍸 𝍸	15
Off color	𝍸 𝍸 𝍸 𝍸 //	22
Bent	𝍸	5
	Grand total:	42

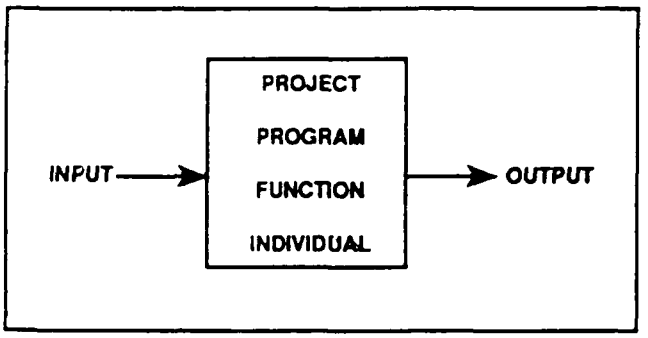
What: A list of check-off items that permit data to be collected quickly and easily in a simple standardize format that lends itself to quantitative analysis. Checksheets are frequently used to collect data on numbers of defective items, defect locations and defect causes.

Why: Facilitates data collection by providing a standardized format for recording information.

How:

1. Identify data to be collected. (Usually data describes problems in a process or defects in a product.)
2. Design checksheet to collect data (may include graphic representations of an object to record where damage is located.)
3. Collect data.
4. Tabulate results. (May record results on a control chart or similar type of diagram.)

Input/Output Analysis

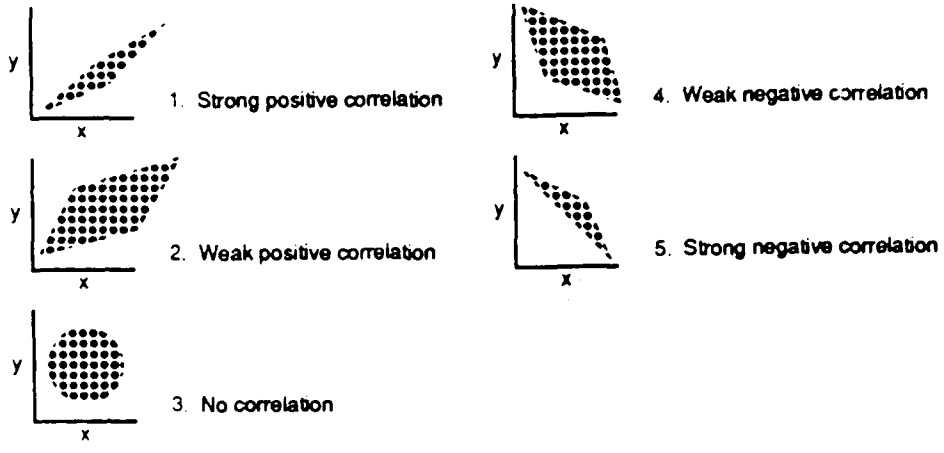


What: Systematic method for identifying interdependency problems by defining objectives and listing inputs and outputs for major tasks, functions, or individuals.

Why: Clarifies roles and responsibilities, resolves conflicts, eliminates duplications, and opens lines of communication.

How:
1. Define program objectives/deliverables, work breakdown structure, master schedule, and actual process.
2. Define prime and support responsibilities.
3. Define each team member's role.
4. Use nominal group technique for improvement ideas.
5. Implement improvement ideas.

Scatter Diagrams



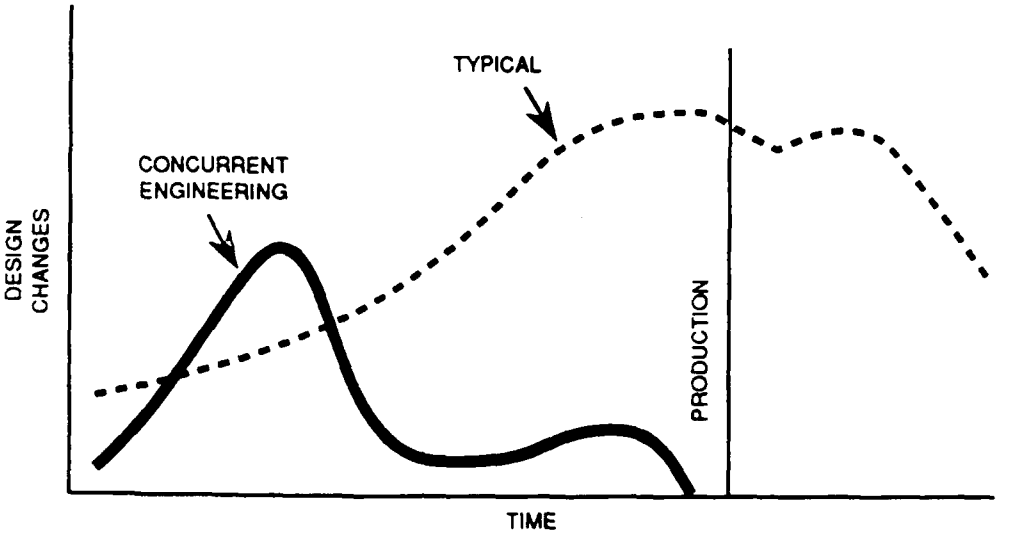
What: Diagrams that depict the relationship between two factors.

Why: Helps lead toward possible causes of problems by determining correlations between two factors.

How:

1. Develop hypothesis about the correlation between two events (e.g., if "x" occurs, then "y" will occur.)
2. Collect data to test hypothesis.
3. Develop graph to summarize results.
4. Analyze results to determine if a cause and effect relationship exists.

Concurrent Engineering



What: **Concurrent engineering** is an approach where design alternatives, manufacturing process alternatives, and manufacturing technology alternatives are dealt with in parallel and interactively beginning with the initial design trade studies.

Traditionally, producibility has been an after-the-fact review of designs to assess the impact of proposed design features on manufacturing cost and to identify alternatives for the major production cost drivers.

With **concurrent engineering**, the focus is on **both** product and process definition simultaneously.

Why: This approach can be used to shorten the design-to-development life cycle, and reduce costs by examining the interaction of functional disciplines from the perspective of a cross-functional process.

(Continued on the next page)

How:

1. Use cross-functional teams.

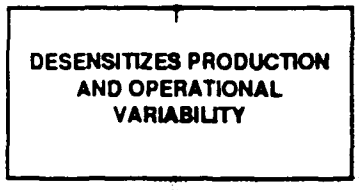
2. Identify and reduce variability in production and use through adroit selection of design parameters.

3. Extend traditional design approach to include such techniques as design for assembly, robust design, computer-aided design, design-for-manufacture, group technology, and value analysis.

4. See also tools:
   - — Design of Experiments
   - — Quality Function Deployment
   - — Transition from Development to Production Templates
   - — Team building.

Reference: Institute for Defense Analyses, **The Role of Concurrent Engineering in Weapon System Acquisition**, IDA Report R-338, December 1988.

Design of Experiments



What: A technique where the experimenter chooses factors for study, deliberately varies those factors in a predetermined way, and then studies the effect of these actions.

Why: Improves the **design-to-production transition** quickly optimizing product and process design. Reduces costs, stabilizes production processes, and desensitizes production variables.

Among the many applications for the design and analysis of experiments are the following:

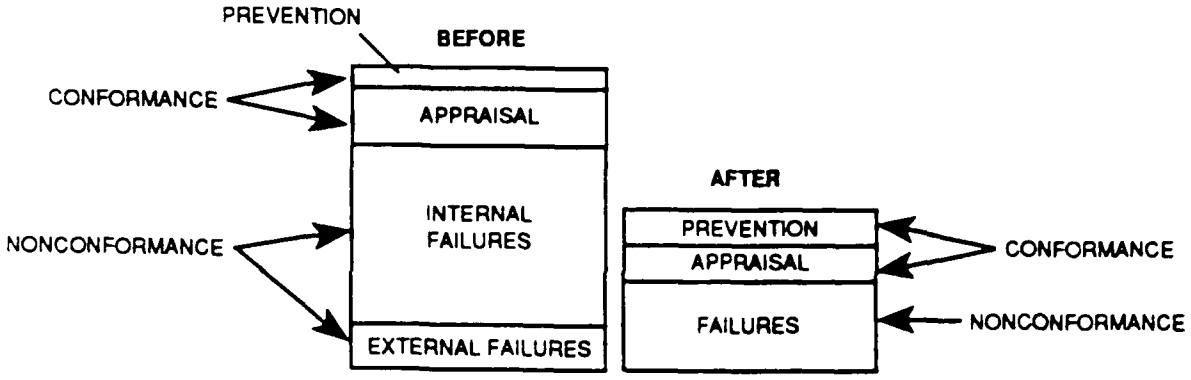
- ❑ Compare two machines or methods
- ❑ Study the relative effects of various process variables
- ❑ Determine the optimal values for process variables
- ❑ Evaluate measurement system error
- ❑ Determine design tolerances.

How:

1. Identify the important variables, whether they be product or process parameters, material or components from suppliers, environmental or measuring equipment factors.
2. Separate these—generally no more than one to four—important variables.
3. Reduce the variation on the important variables (including the tight control of interaction effects) through redesign, close tolerancing design, supplier process improvement, etc.
4. Open up the tolerances on the unimportant variables to reduce costs.

Reference: Taguchi, Shin and Byre, Diane M. **The Taguchi Approach to Parameter Design**, American Society of Quality Control (40th Annual Quality Conference Transactions).

Cost of Quality



What: A system providing managers with cost details often hidden from them. **Cost of Quality** consists of all the costs associated with maintaining acceptable quality plus the costs incurred as a result of failure to achieve this quality.

Why: The cost of not doing things right the first time can be considerable. This includes administrative work.

How:

1. Identify quality costs. These are cost of nonconformance and cost of conformance as shown on the diagram.
2. Develop method for collecting data and reporting on cost of quality
3. Identify the most significant costs.
4. Identify the causes of these major costs.
5. Identify solutions to reduce or eliminate causes.
6. Implement solutions.

(Continued on the next page)

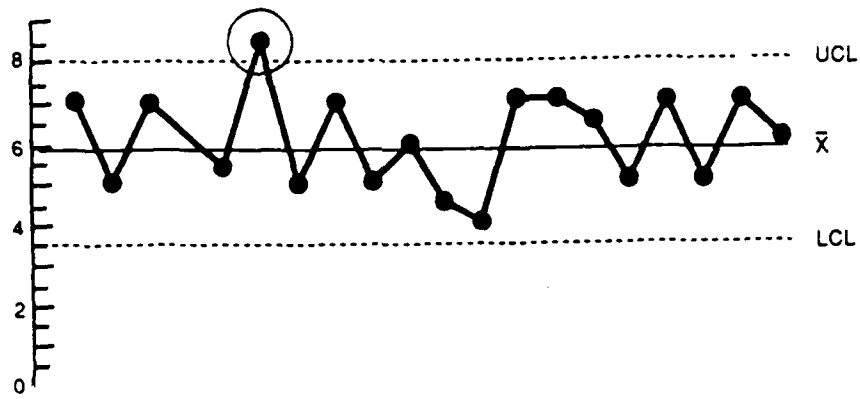
Cost of Quality Examples

- **Prevention:**
  - — Quality engineering
  - — Quality planning
  - — Design verification and review of manufacturability of new products
  - — Quality training
  - — Quality improvement projects
  - — Statistical process control activities.
- **Appraisal:**
  - — In–process inspection
  - — Set–up for testing
  - — Administrative costs for quality assurance personnel.
- **Internal Failure:**
  - — Scrap
  - — Rework
  - — Reinspection of rework
  - — Downtime caused by defects
  - — Investigation of failure or rework.
- **External Failure:**
  - — Warranty adjustments.
  - — Repairs
  - — Customer service
  - — Returned goods
  - — Investigation of defects
  - — Product liability suits.

References: Principles of Quality Costs, Jack Canpanella and Frank J. Corcoran, **Quality Progress**, April 1983.

Let's Help Measure and Report Quality Cost, **Management Accounting**, August 1983.

Control Charts



What: A graphic representation of measured actual process performance relative to computed control limits. They are used to show the variation on process variables and identify special causes.

Why: Allows you to distinguish between measurements that are predictably within the inherent capability of the process (**common causes** of variation) and measurements that are unpredictable and produced by **special causes**.

How:

1. Determine control limits to describe the expected variation of a process.
2. Collect data.
3. Plot data on control chart to assess performance and identify points outside established control limits.
4. Determine causes of points outside control limits.
5. Identify ways to eliminate special causes, reduce normal variation, and improve the mean.

Work Flow Analysis (WFA)

PROCESS / SUBPROCESS STEPS	STEP 1	STEP 2	STEP 3	STEP 4	STEP 5	ETC...
DESIRED PERFORMANCE						
ACTUAL PERFORMANCE						
CAUSE OF GAP						
RECOMMENDED CHANGES						

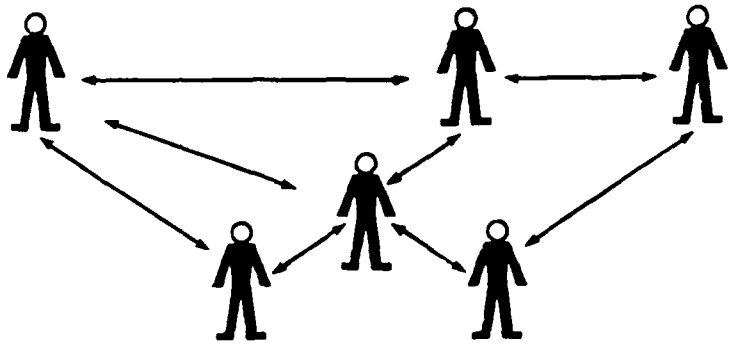
What: A structured system to improve a work process by eliminating unnecessary tasks and streamlining the work flow.

Why: There is almost always a better, easier way to do something. **WFA** identifies and eliminates unnecessary process steps by analyzing functions, activities, and tasks. Uses cross-functional teams.

How:

1. Define process in terms of purposes, objectives, start and end points.
2. Identify functions and major responsibilities of the organization including manpower and planning.
3. Identify activities below functions.
4. Identify tasks or basic steps used to perform each activity and to provide the most specific description of a process.
5. Analyze the process with a cross-functional team.
6. Identify lengthy tasks, choke points, duplicative tasks, etc.
7. Determine and implement an action plan for improvement.

Team Building



What: Developing and maintaining a group of people who are working together for a common goal.

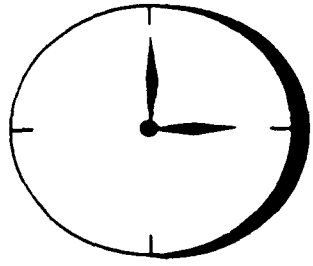
Why: When a job requires interdependence among the people working on the job, it is important to ensure that these people can and will work together smoothly.

How: Rules to remember: Do not ignore team/team member problems; balance between the needs of the individuals, the team, and the goal.

1. Identify the team.
2. Develop the team: teach group problem-solving, openly share data, build norms of shared and collaborative action, and teach team members to reinforce one another.
3. Identify team goals.
4. Empower the team members
5. Recognize team accomplishments regularly.
6. Maintain the team.

Reference: Dyer, William G. **Team Building: Issues and Alternatives**: Reading, MA: Addison-Wesley Publishing Co. 1977, p. 139.

Time Management



What: Managing time to gain greater flexibility and control of activities—an important aspect of implementing TQM.

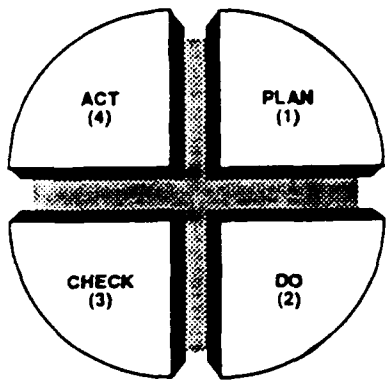
Why: TQM is implemented by busy people. By using the discipline of time management, discretionary time can be increased and applied to improvement efforts. Many activities associated with TQM involve better use of time, e.g., cycle time reduction.

How: 1. Prioritize activities. Suggest using an "**ABC**" approach.
— "A" activities are *must do.*
— "B" activities are beneficial but not mand[illegible]
[illegible]ities are unnecessary and [illegible]

2. Identify and remove time wasters such as:

- Unclear objectives
- Postponed decisions
- Lack of information
- Interruptions
- Lack of self-discipline
- Lack of priorities
- Junk mail
- Unnecessary meetings
- Crisis management
- Red tape
- Can't say no
- Mistakes
- Poor information
- Procrastination
- Lack of feedback
- Telephone
- Visitors
- Failure to delegate
- Absense of procedure for routine matters
- Shortage of managerial tools
- Poor physical fitness
- Inconsistent actions
- Low morale

The Shewhart Cycle (Deming)



What: A cyclic process for planning and testing improvement activities prior to full-scale implementation.

Why: When an improvement idea is identified, it is often wise to test it on a small scale prior to full implementation to validate its benefit. Additionally, by introducing a change on a small scale, employees have time to accept it and are more likely to support it.

How:

1. Plan a change or test.
2. Carry out the change or test, preferably on a small scale.
3. Observe the effects of the change or test.
4. Act on what was learned.
5. Repeat Step 1, with new knowledge.
6. Repeat Step 2, and onward.

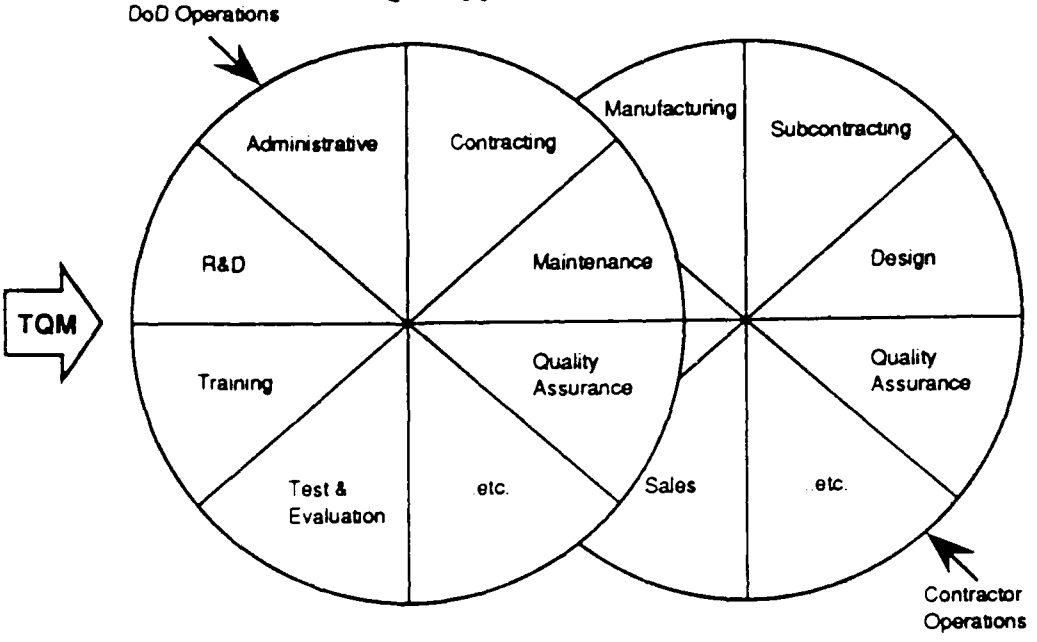
Appendix A

TQM Related Initiatives in DoD Systems Acquisition

APPENDIX A
TQM RELATED INITIATIVES IN DoD SYSTEMS ACQUISITION

To this point, the basis for conducting a TQM effort in any organization—government or industry—has been provided. In view of the criticality of system acquisition in the context of national security, it is imperative that the TQM concepts, practices, tools, and techniques be rapidly integrated into the DoD system acquisition process. Steps toward achieving this end include developing appropriate contractual language and making TQM a consequential factor in the source selection process.

TQM Applies Universally



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By applying TQM priniciples to the acquisition process, DoD strives to be a world-class customer, as well as a quality supplier. In this section, a number of DoD acquisition initiatives are presented in summary form. Some of these initiatives were developed prior to the development of the TQM philosophy and, therefore, may not be integrated and consistent in all aspects with TQM. Therefore, they may need to be modified in order to apply them in a manner consistent with the TQM philosophy.

The initiative on **Transition from Development to Production Templates** has been revised to include TQM. Others are supportive of TQM. For example, **Acquisition Streamlining** clarifies customer requirements. **Exemplary Facilities** promotes use of **SPC**. **R&M 2000** promotes use of variability reduction and **QFD**.

TQM suppliers require TQM customers.

DoD Total Quality Management Initiatives

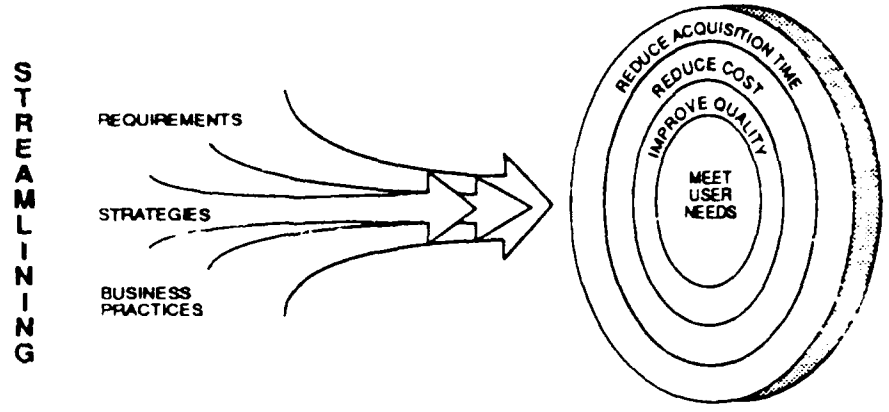
DOD intiatives listed here will leverage the benefits achieved by implementing the TQM model.

ORIENTATION	DEFINING CONTRACT REQMTS	DESIGN	PRODUCTION	FOCUS
DoD WIDE				
1 ACQUISITION STREAMLINING	✓			1 SPECIFY TRUE CUSTOMER REQUIREMENTS AND STATE WHAT, NOT HOW
2 COULD COST	✓			2 ELIMINATE NON-VALUE-ADDED RULES/REGULATIONS
3 TRANSITION FROM DEVELOPMENT TO PRODUCTION		✓	✓	3 USE TEMPLATES FOR REDUCING RISK
4 INDUSTRIAL MODERNIZATION INCENTIVES PROGRAM	✓		✓	4 CONTRACT INCENTIVES FOR CONTRACTOR MODERNIZATION AND PRODUCTIVITY IMPROVEMENT
5 VALUE ENGINEERING	✓	✓	✓	5 USE TO ANALYZE FUNCTIONS FOR IMPROVEMENT
6 EXEMPLARY FACILITIES *			✓	6 IMPLEMENT PROCESS CONTROL & YIELD IMPROVEMENT
7 PRODUCT NON-CONFORMANCE REDUCTION			✓	7 ENCOURAGE QUALITY IMPROVEMENT THROUGH USE OF INCENTIVES/PENALTIES
ARMY				
1 (CP) [2]			✓	1 USE SPC TO REDUCE GOVERNMENT INSPECTION
AIR FORCE				
1 R&M 2000		✓	✓	1 UTILIZE VARIABILITY REDUCTION, DESIGN OF EXPERIMENTS, QUALITY FUNCTION DEPLOYMENT
DEFENSE LOGISTICS AGENCY (DCAS)				
1 TQUE		✓	✓	1 REPLACE INSPECTION AND CHECKLISTS WITH TQM APPROACH

* PIONEERED BY NAVY

The following pages provide descriptions for each of the above initiatives.

Acquisition Streamlining



What: A set of actions to eliminate unnecessary or conflicting requirements that compound cost and time without adding capability to DoD acquisitions. A way for producers (industry) to help the customer (DoD) define requirements and reduce cost.

Why: To promote innovative and cost-effective acquisition strategies and requirements that will result in the most efficient utilization of resources to produce quality weapons systems and products. **Acquisition Streamlining** can reduce the cost and/or time of system acquisition and life-cycle cost without degrading system effectiveness.

(Continued on the next page)

How:

1. Specify requirements in terms of results desired, not "how-to-design" or "how-to-manage." The use of Quality Function Deployment (QFD) may be helpful.
2. Preclude premature application of design solutions and specifications.
3. Tailor requirements to unique circumstances of individual programs.
4. Limit the contractual applicability of referenced documents.

References: DoD Directive 5000.43 **"Acquisition Streamlining."**

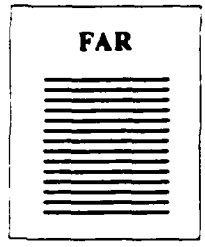
MIL-HDBK-248 **"Acquisition Streamlining."**

Defense Acquisition Circular, 1 November 1988, Number 88-1.

Federal Acquisition Circular, September 2, 1988, Number 84-39.

Department of Navy Handbook, Implementation of Non-Developmental Item Acquisitions, 6 June 1988.

Could Cost



What: An approach aimed at substantial quality improvement and cost reductions in developing and producing weapon systems and other military products and services through elimination of unnecessary procurement regulations.

Why: **Could Cost** is a way to get industry and government to work together to eliminate non-value-added effort. **Could Cost** is a new way of doing business, but most changes require no new policy directives or legislation. The one restriction is that all requirements imposed by law or executive orders must be complied with. All internally imposed rules, regulations, and conventions are subject to critical examination and challenge.

How: *Contractor:* 1. Develop **Could Cost** proposal for changes to RFP.

2. Coordinate with key suppliers.

DoD: 3. Evaluate proposal in source selection.

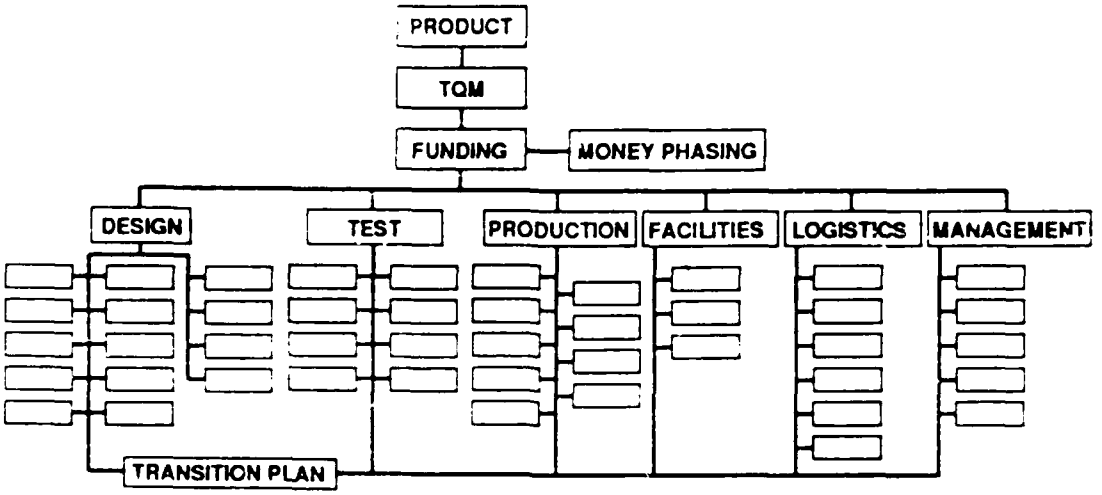
4. Negotiate changes after contract award.

5. Reduce contract price by negotiating cost reduction for changes.

Contractor: 6. Execute agreements with key subcontractors.

Reference: Memorandum for the Secretaries of the Military Departments and Directors of the Defense Agencies, 1 May 1988.

Transition from Development to Production



What: The ***Transition from Development to Production Directive*** requires the application of integrated design and engineering disciplines in the construction and conduct of defense acquisition programs. Use of a formal risk reduction program is also prescribed for which a guidance manual containing 48 "templates" is provided. The templates cover the areas found through experience and by the Defense Science Board to be critical to success of the system. This "Transition" manual treats acquisition as an "industrial process" and is a TQM document in concept. It is written from both industry and DoD perspectives.

(Continued on the next page)

Why: Cost, schedule, and performance problems in acquisition manifest themselves as failure to make a smooth transition from development to production and initial deployment. Failure is most frequently a consequence of treating transition as a managerial event rather than a technical process. A successful process considers all life cycle disciplines, including producibility and supportability, from the outset and establishes a continuum of integrated design, test, production, and support.

How: The templates of the **Transition** and **Best Practices Manuals** are used to identify the most frequently encountered risks and to describe the attributes and characteristics of a low-risk program. Risk is reduced and improvement is made when the process is changed. Each template includes a timeline suggesting when the activity might best begin and be completed or operational. Refer to the Defense Production Management Directive for a listing of the production activities to be addressed specifically at each milestone decision point. Change 1 to DoD 4245.7-M provides special coverage on implementing TQM in the acquisition process.

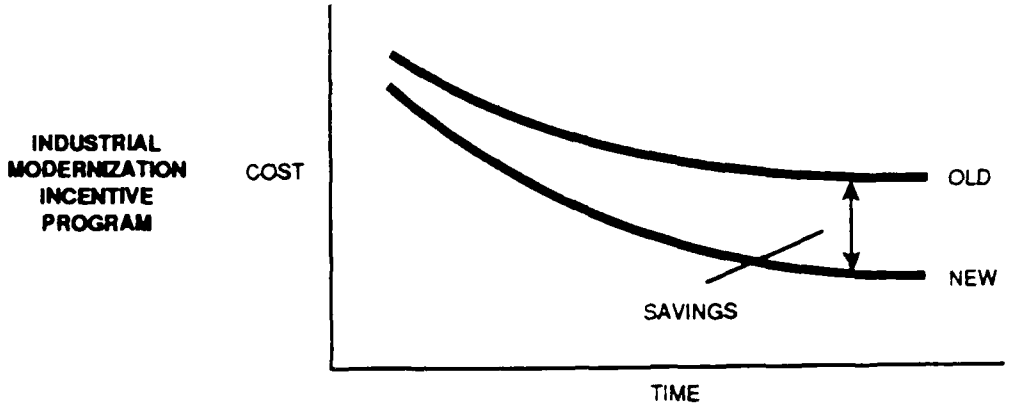
References: DoDD 4245.6, **Defense Production Management.**

DoDD 4245.7, **Transition from Development to Production.**

DoD 4245.7-M, **Transition from Development to Production.**

NAVSO P-6071, **Best Practices.**

Industrial Modernization Incentive Program (IMIP)



What: A DoD program that provides incentives for contractor modernization and productivity improvement. Focuses on shared savings rewards and contractor investment protection.

Why: DoD wants to eliminate inhibitions to modernization and progress of productivity. These inhibitions are usually created by definitions of allowable cost in the DoD acquisition process. Two major problems are program uncertainties and cost-based profit policies. **IMIP** will develop contract incentives aimed at encouraging industry to make productivity-enhancing capital investments. **IMIP** provides contractors with a nominal financial sharing of capital investments and a sharing of realized savings. **IMIP** will increase industrial competitiveness, reduce lead times, and increase effectiveness of research and development, procurement, and logistics.

How:

1. Establish a memorandum of agreement covering modernization plans.

2. Establish an incentive structure based on the accomplishment of achievements set forth in the approved plan.

Reference: Stimson, R.A. and Reeves, A.D. **Tri-Service DoD Program Provides Incentives for Factory Modernization**, Industrial Engineering, Feb. 1984, vol 16, No. 2, pp. 54-61.

DoD 5000.44G, **Industrial Productivity Incentive Program.**

Value Engineering

What: A systematic functional analysis leading to actions or recommendations to improve the value of systems, equipment, facilities, services, and supplies. Value being the best balance between performance and cost. (Terms such as value analysis, value control, value improvement, and value management are synonymous.)

Why: To simultaneously improve quality, reduce cost, and improve schedules.

How:

1. Identify required functions.
2. Analyze current solution by breaking into primary parts, which address required functions; and secondary parts, which support primary parts.
3. Identify cost associated with each part.
4. Identify cost to perform required functions.
5. Minimize secondary parts.
6. Develop alternative solutions with associated costs that meet required functions.
7. Select and implement solution that provides the best value.

References:

DoD Directive 4245.8, **Value Engineering Program**, March 20, 1987.

Federal Acquisition Regulation (FAR), Chapter 1, Subchapter G, Part 48, April 1, 1984.

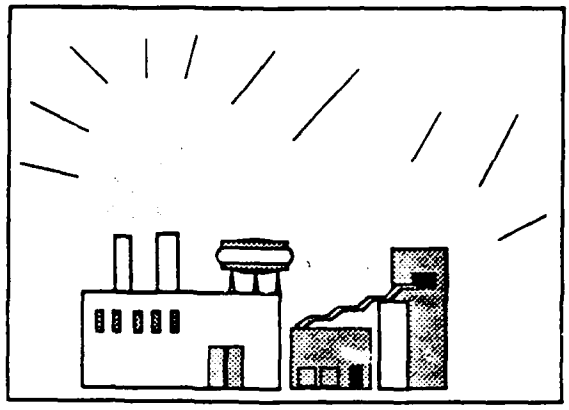
Defense Acquisition Circular 86-6, 1 September 1987.

DoD Handbook 4245.8 H, **Value Engineering**, March 17, 1986.

DLAH 8400.4, **Value Engineering - Guidebook for DoD Contractors**, April 1988.

Techniques of Value Analysis and Engineering, Lawrence D. Miles, McGraw Hill Book Company, 1961.

Exemplary Facilities



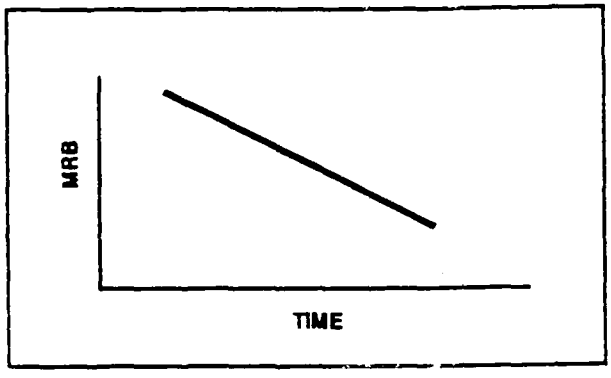
What: A program that consolidates the various military services' approaches for dealing with contractors who exhibit continued ability to supply superior products to DoD within the confines of their contractual requirements. An example is the Army $(CP)^2$ program.

Why: To improve the ability of the Department of Defense to obtain quality weapon systems at reasonable cost and to integrate the various efforts of DoD components into a consistent contractor quality improvement approach. A contractor who is an **exemplary facility** will have less government oversight. If his quality deteriorates, he will again be subject to full, routine surveillence.

How:
1. Provide business incentives, not necessarily financial, to encourage better contractor quality performance.
2. Provide incentives for contractors to provide continuous quality improvement.
3. Refocus government surveillance once contractor reaches exemplary facility status.

Reference: Draft **Exemplary Facilities** Concept Paper (Navy)
(Note: This draft paper is currently under test.)

Product Nonconformance Reduction



What: A policy focusing on actions to be taken early in the design, development, and production of new systems, subsystems, and equipment in order to prevent nonconformance (Material Review Board action on Type II quality deficiencies). This policy is enacted when:

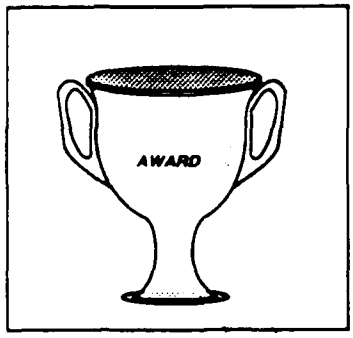
1. Quality program for a contract is out of control.
2. Procuring agency has given approval.

Why: It is government policy to reject material and supplies not conforming in all respects to contract requirements. The **Product Nonconformance Reduction** policy reduces costs and delays incurred from rejecting contractor products by setting objectives for contractors to reduce or eliminate nonconformance and promote continuous quality improvement.

How: Set targets for yield improvement. Assess rewards/penalties based on performance to goals.

Reference: Joint Services Regulation #702-17, **Quality Improvement Product Nonconformance Reduction (Draft).**

Contractor Performance Certification Program $(CP)^2$



What: The Army's program that rewards quality improvement by decreasing surveillance. It emphasizes the need for quality management and planning. It recognizes defense contractors who have proven they provide quality products and the products and services provided by their suppliers. The Army will decrease oversight over contractors who are certified to meet these requirements. Offered on major programs ($100M R&D/$500M production). This program and the **Exemplary Facilities Program** may be merged in the future.

Why: Recognize contractor commitment to continuous quality improvement.

How:

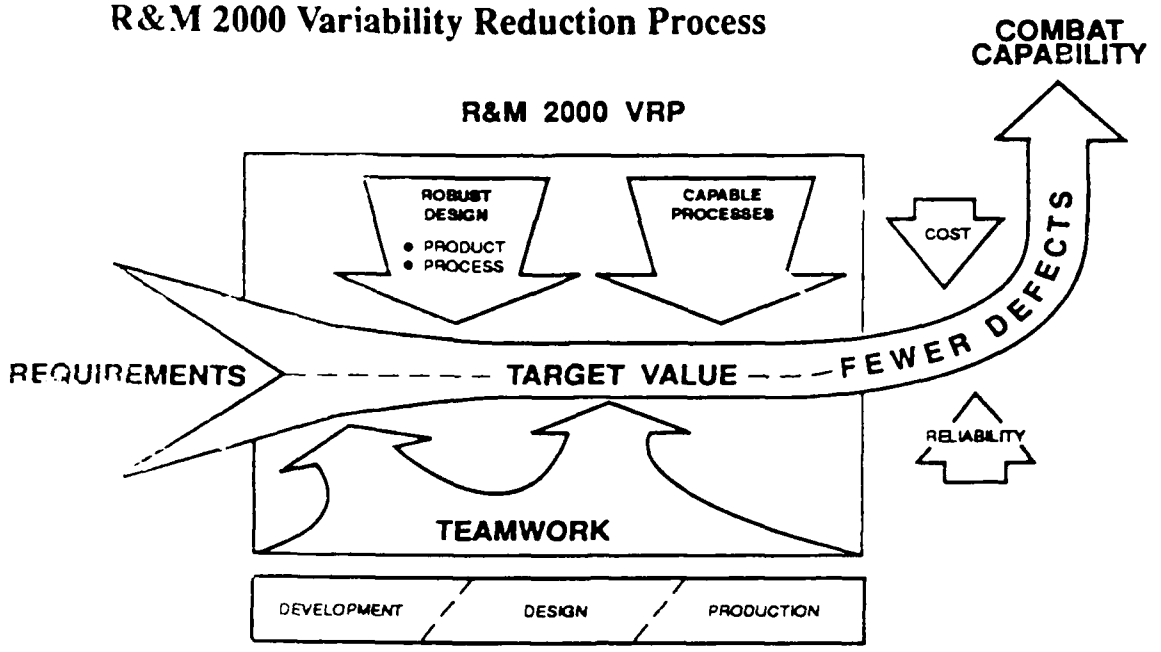
1. Contractor's quality performance programs must include Statistical Process Control (**SPC**).

2. The contractor should have a tailored plan for $(CP)^2$ addressing: contractor responsibilities for control of processes, corrective actions, internal audits, vendor/manufacturing capabilities, trend analysis, improvement goals, and measurable milestones for goal achievement.

3. Contractor performance should be judged in terms of: evidence of having consistently produced delivered supplies conforming to contract requirements; evidence of an effective **SPC** system for both procured and manufactured material; an aggressive, continuous effort to improve quality and productivity; establishment of a satisfactory support system responsible for coordinating user feedback; and incorporation of a cost-effective, total audit system to track performance against established milestones.

Reference: AMC-R 702-9

R&M 2000 Variability Reduction Process



What: The **R&M 2000 Variability Reduction Process (VRP)** is a means to improve the reliability and maintainability of DoD weapons systems while reducing development and production time and cost. The traditional approach to improving a product has been to tighten tolerances and more inspections, but this does not resolve the underlying problems. The only way to reduce the effects of process variation is to eliminate the causes of variation or minimize their effects.

Why: Systems fail prematurely because of poor design, the use of defective parts and materials, or poor workmanship. Most of these failures are due to variability in the manufacturing and repair processes. Variability comes from the fact that conditions under which these systems were produced or repaired change. Reducing variability around the target value increases productivity and eliminates waste during manufacturing, repair, and use. Having capable manufacturing and repair processes is not enough. In many cases, the causes of variability are difficult to remove or control. For this reason, it is important to develop robust production processes that are insensitive to the manufacturing environment, and robust designs that are insensitive to the operational environment.

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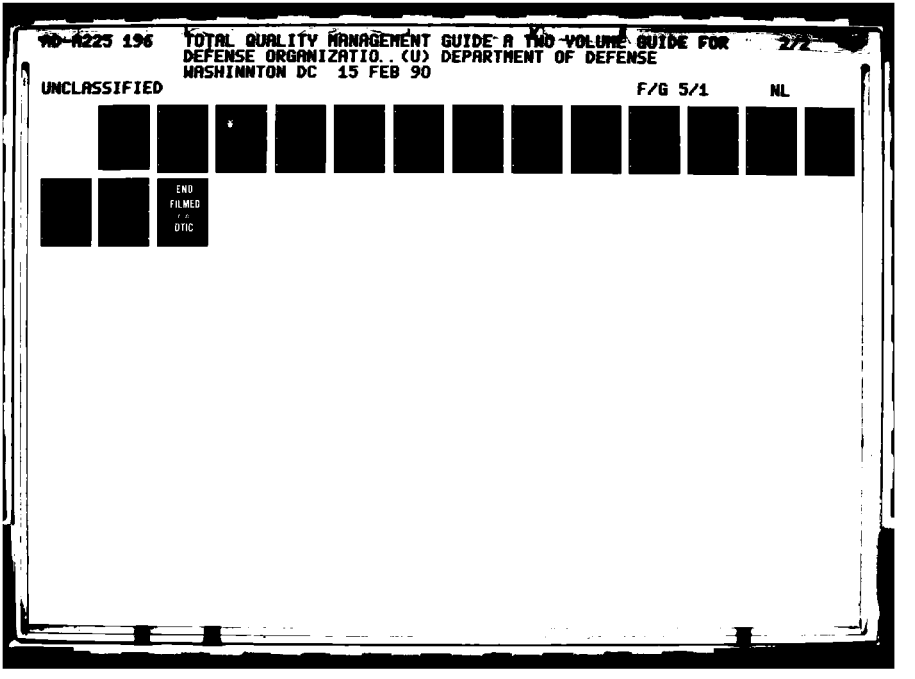
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How: The **VRP** strategy is to develop robust systems that are insensitive to variations; to achieve capable manufacturing and repair processes that produce uniform, defect-free products; and to adopt the managerial attitude of continuously improving all processes. The basic tools are teamwork, SPC, the quality loss function, design of experiments, parameter design and quality function deployment. **VRP** must span all of engineering, manufacturing, and management, and include the suppliers.

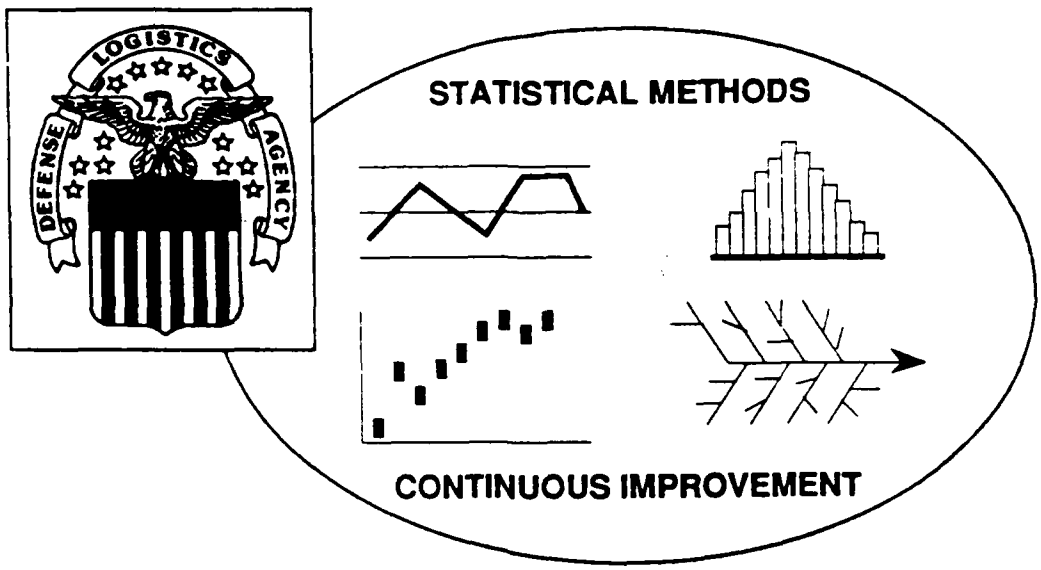
References: AFP 800-7, **USAF R&M 2000 Process**, 1 January 1989.

R&M 2000 Policy Letter, **Variability Reduction**, No. 6, July 14, 1988.

"Improving Combat Capability through R&M 2000 Variability Reduction", HQ USAF/LE-RD, January 1989.

VRP Guidebook, HQ USAF/LE-RD, June 1989.

In–Plant Quality Evaluation (IQUE)



What: A Defense Logistics Agency/Defense Contract Administration Service (DLA/DCAS) program to replace the traditional QA procedures with a TQM approach and modern techniques. **IQUE** focuses on measuring and continuously improving process quality rather than on rigid, cookbook procedures and product inspection.

Why: The traditional "policeman" approach of end-item inspection and rigid checklists proved to have little impact on product quality while creating an inordinate amount of paperwork. By using the **IQUE** approach, DCAS strives to encourage job ownership and employ modern tools to "build-in" quality from the start, eliminating costly corrective action.

How:
1. Analyze/understand flow of processes
2. Determine key processes for government review
3. Determine types of contractor data needed to measure processes
4. Establish product audits for variable/problem processes
5. Orient oversight to enhance continuous process improvements

Note: IQUE is currently undergoing test in selected locations.

APPENDIX B

References and Suggested Readings

The key to effective and successful implementation of TQM is understanding the underlying philosophy and theories that support continuous process improvement efforts. DoD and industry personnel can greatly benefit from the references listed below. The following suggested books are some of the best in the field of continuous process improvement. Though the list is not exhaustive, the references will provide a sound basis for understanding the TQM philosophy.

American Society for Quality Control: American National Standard. **Management System for Quality**, 1989.

AT&T: **Process Quality Management & Improvement Guidelines**, 1987.

Defense Systems Management College: **Managing Quality and Productivity in Aerospace and Defense**, Fort Belvoir, Virginia, December, 1988.

Deming, W. Edwards: **Out of the Crisis**, Massachusetts Institute of Technology, Center for Advanced Engineering Study, Cambridge, Mass., 1986.

Department of Defense: **DoD Directive on Total Quality Management**, 1989.

Feigenbaum, Amand V.: **Total Quality Control**, McGraw-Hill Book Company, New York, 1983.

Gavin, David A.: **Managing Quality**, The Free Press, New York, 1988.

Harrington, H. James: **The Improvement Process**, McGraw-Hill Book Company, New York, 1987.

Honeywell Aerospace and Defense Management Development Center: **A&D's Future and You. A Performance Improvement Guide.**

Imai, Masaaki: **Kaizen**, Random House, New York, 1986.

Ishikawa, Kaoru: **What is Total Quality Control?** Prentice-Hall, Englewood Cliffs, N.J., 1985.

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Juran, J. M.: **Managerial Breakthrough**, McGraw-Hill Book Company, New York, 1964.

Logistics Management Institute: **Total Quality Management. A Guide to Getting Started. (Draft)**, 1989.

Scholtes, Peter R.: **The Team Handbook**, Joiner Associates, Madison, Wisconsin, 1988.

Scherkenbach, William: **The Deming Route to Quality and Productivity**, Cee Press, Washington, D.C., 1986.

Schonberger, Richard J.: **Japanese Manufacturing Techniques: Nine Hidden Lessons in Simplicity**, The Free Press, New York, 1982.

Townsend, Patrick L.: **Commit to Quality**, John Wiley and Sons, New York, 1986.

The Federal Quality Institute

The Federal Quality Institute is focusing its efforts in three areas.

First, it provides quality awareness training courses to federal government management teams. This one-day course provides managers with the information they need to make decisions about where to begin the TQM journey.

Second, the Institute has available through the Office of Personnel Management (OPM) a Federal Master Contract, consisting of private-sector quality experts that agencies can use to assist them in implementing TQM. This expertise is available without the need to work through a lengthy contracting process since the contract was competitively awarded.

Third, the Institute maintains a Quality and Productivity Resource Information Center, an extensive library of materials on quality practices and training.

For information contact:

Federal Quality Institute
P.O. Box 99
Washington, D.C. 20044-0099
(202)376-3747

Defense Systems Management College

Total Quality Management Course
New Course Offered in 1989

This course addresses theory and application of TQM principles in the DoD environment. An interdisciplinary course, it covers current DoD initiatives and their impacts in the areas of technical, financial, and acquisition policy. Selected guest lecturers from government, the defense industry, and commercial industry discuss TQM applications and problems unique to the DoD. Case studies allow the student to analyze and provide solutions to current problems facing DoD and industry program managers. Study objectives, assigned readings, and functional lectures guide the students, who are encouraged to present actual problems for class discussion and analysis.

Course Eligibility:

The course is open to military officers in grades O–4 through O–6 and civilians in grades GS–13 through GS–15. Individuals holding equivalent grades in other federal agencies and defense-related industries are encouraged to attend.

Students are introduced to the concept of variability in design and manufacturing, statistical process control, and experimental design based on works by Dr. W. Edwards Deming and Dr. Genichi Taguchi. Other issues include streamlining contractual requirements; improving interaction among designers, manufacturing engineering, logisticians and users: and making a contractor's past performance and quality history a factor in source selection.

The goal of the course is to establish a sound technical and management foundation that can be tailored to individual DoD programs.

For information contact: (703) 664–2457 or Autovon 354–2457

Glossary of Terms & Definitions

Appraisal Costs — These are the costs associated with inspecting the product to ensure that it meets the customer's (either internal or external) needs and requirments.

Best of Class — Best of class is when overall performance, in terms of effectiveness, efficiency, and adaptability, is superior to all comparables.

Cause — An established reason for the existence of a defect.

Common Cause — A source of variation in the process output that is inherent to the process and will affect all the individual results or values of process output.

Control — The set of activities employed to detect and correct deviation in order to maintain or restore a desired state. A past-oriented approach to quality management.

Correction — The totality of actions to minimize or remove variations and their causes.

Cost of Quality — The sum of the cost of prevention, appraisal, and failure. The key financial measurement tool that ties process control and process optimization into a total process management effort. It can be used both as an indicator and a signal for variation (more often, patterns of variation), as well as a measure of productivity and efficiency.

Corrective Action — The implementation of effective solutions that result in the elimination of identified product, service, and process problems.

Culture — A prevailing pattern of activities, interactions, norms, sentiments, beliefs, attitudes, values, and products in an organization.

Customer	The recipient or beneficiary of the outputs of your work efforts or the purchaser of your products and services. May be either internal or external to the organization. The recipient that must be satisfied with the output.
Data	Information or a set of facts presented in descriptive form. There are two basic kinds of data: measured (also known as variable data) and counted (also known as attribute data).
Defect	Any state of nonconformance to requirements.
Detection	An outcome-oriented approach to quality management based on the identification of nonconformances after the fact; its result is the identification of defects and their causes.
Deviation	Any nonconformance to a standard or requirement.
Effectiveness	A process characteristic indicating that the process output (work product) conforms to requirements.
Efficiency	A process characteristic indicating that the process produces the required output at a perceived minimum cost.
External Failure Costs	These are the costs incurred when an external customer receives a defective product.
Federal Acquisition Regulation (FAR)	A government regulation defining the policies for acquiring goods and services.
Frequency Distribution	1) (of a discrete variable) The count of the number of occurrences of individual values over a given range. 2) (of a continuous variable) The count of cases that lie between certain predetermined limits over the range of values the variable may assume.
Functional Organization	An organization responsible for one of the major organizational functions such as marketing, sales, design, manufacturing, and distribution.

Gainsharing	A reward system that shares productivity gains between owners and employees. Gainsharing is generally used to provide incentive for group efforts toward improvement.
Goal	A statement of attainment/achievement that one proposes to accomplish or attain with an implication of sustained effort and energy directed to it over a longer range.
Guideline	A suggested practice that is not mandatory in programs intended to comply with a standard.
Hypothesis	An assertion made about the value of some parameter of a population.
Input	Materials, energy, or information required to complete the activities necessary to produce a specified output (work product).
Internal Failure Costs	These are the costs generated by defects found within the enterprise, prior to the product reaching the external customer.
Mean Time Between Failures (MTBF)	The average time between successive failures of a given product.
Measurement	The act or process of measuring to compare results to requirements. A quantitative estimate of performance.
Need	A lack of something requisite, desired, or useful; a condition requiring provision or relief. Usually expressed by users or customers.
Objective	A statement of the desired result to be achieved within a specified time. By definition, an objective always has an associated schedule.
Output	The specified end result. Required by the recipient.
Outputs	Materials or information provided to others (internal or external customers).

Performance — The term performance is used as an attribute of the work product itself and as a general process characteristic. The broad performance characteristics that are of interest to management are quality (effectiveness), cost (efficiency), and schedule. Performance is the highly effective common measurement that links the quality of the work product to efficiency and productivity.

Plan — A specified course of action designed to attain a stated objective.

Policy — A statement of principles and beliefs, or a settled course, adopted to guide the overall management of affairs in support of a stated aim or goal. It is mostly related to fundamental conduct and usually defines a general framework within which other business and management actions are carried out.

Population — A large collection of items (product observations, data) about certain characteristics of which conclusions and decisions are to be made for purposes of process assessment and quality improvement.

Prevention — A future-oriented approach to quality management that achieves quality improvement through curative action on the process.

Prevention Costs — These are the costs associated with actions taken to plan the product or process to ensure that defects do not occur.

Problem — A question or situation proposed for solution. The result of not conforming to requirements or, in other words, a potential task resulting from the existence of defects.

Process — A system in operation to produce an output of higher value than that of the sum of its inputs. A process is also defined as the logical organization of people, materials, energy, equipment, and procedures into work activities designed to produce a specified end result (work product).

Process Capability	Long-term performance level after the process has been brought under control.
Process Control	The set of activities employed to detect and remove special causes of variation in order to maintain or restore stability (statistical control).
Process Improvement	The set of activities employed to detect and remove common causes of variation in order to improve process capability. Process improvement leads to quality improvement.
Process Management	Management approach comprising quality management and process optimization.
Process Optimization	The major aspect of process management that concerns itself with the efficiency and productivity of the process; that is, with economic factors.
Process Owner	A designated person within the process, who has authority to manage the process and responsibility for its overall performance.
Process Performance	A measure of how effectively and efficiently a process satisfies customer requirements.
Process Review	An objective assessment of how well the methodology has been applied to your process. Emphasizes the potential for long-term process results rather than the actual results achieved.
Productivity	The value added by the process divided by the value of the labor and capital consumed.
Quality Improvement Team	A group of individuals charged with the task of planning and implementing quality improvement. The three major roles in this task force are team leader, team facilitator, and team member.
Quality of Requirements	Conformance of requirements to known user needs and the expected manner in which they are to be met.

Range	The difference between the maximum and the minimum value of data in a sample.
Reliability	The probability of a product entity's performing its specified function under specified conditions, without failure, for a specified period of time.
Requirement	A formal statement of a need and the expected manner in which it is to be met.
Requirements	What is expected in providing a product or service. The "it" in "do it right the first time." Specific and measurable customer needs with an associated performance standard.
Root Cause	Original reason for nonconformance within a process. When the root cause is removed or corrected, the nonconformance will be eliminated.
Sample	A finite number of items taken from a population.
Simulation	The technique of observing and manipulating an artificial mechanism (model) that represents a real-world process that, for technical or economical reasons, is not suitable or available for direct experimentation.
Special Cause	A source of variation in the process output that is unpredictable, unstable, or intermittent. Also called assignable cause.
Specification	A document containing a detailed description or enumeration of particulars. Formal description of a work product and the intended manner of providing it. (The provider's view of the work product.)
Standard Deviation	A parameter describing the spread of the process output, denoted by the greek letter sigma, σ. The positive square root of the variance.

Statistic

Any parameter that can be determined on the basis of the quantitative characteristics of a sample.

- A descriptive statistic is a computed measure of some property of a set of values, making possible a definitive statement about the meaning of the collected data.
- An inferential statistic indicates the confidence that can be placed in any statement regarding its expected accuracy, the range of applicability of the statement, and the probability of its being true. Consequently, decision can be based on inferential statistics.

Statistics

The branch of applied mathematics that describes and analyzes empirical observations for the purpose of predicting certain events in order to make decisions in the face of uncertainty. Statistics, in turn, are based on the theory of probability. The two together provide the abstraction for the mathematical model underlying the study of problems involving uncertainty.

Statistical Control

The status of a process from which all special causes of variation have been removed and only common causes remain. Such a process is also said to be stable.

Statistical Estimation

The analysis of a sample parameter in order to predict the values of the corresponding population parameter.

Statistical Methods — The application of the theory of probability to problems of variation. There are two groups of statistical methods:

- ❑ Basic statistical methods: Relatively simple problem-solving tools and techniques, such as control charts, capability analysis, data summarization and analysis, and statistical inference.
- ❑ Advanced statistical methods: More sophisticated and specialized techniques of statistical analysis, such as the design of experiments, regression and correlation analysis, and the analysis of variance.

Strategy — A broad course of action, chosen from a number of alternatives, to accomplish a stated goal in the face of uncertainty.

Subprocesses — The internal processes that make up a process.

Suppliers — Individuals or organizations or firms who provide inputs to you. Suppliers can be internal or external to a company, firm, or organization.

Variable — A data item that takes on values within some range with a certain frequency or pattern. Variables may be discrete; that is, limited in value to integer quantities (for example, the number of bolts produced in a manufacturing process); discrete variables relate to attribute data. Variables may also be continuous, that is, measured to any desired degree of accuracy (for example, the diameter of a shaft); continuous variables relate to variables data.

Variance — In quality management terminology, any nonconformance to specifications. In statistics, it is the square of the standard deviation.